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A PECULIAR PHENOMENON.

While the cause of the phenomenon described by Mr. M. W. Hassan in another column may not have the appearance of an acoustic one, it can scarcely be ascribed to an electro-magnetic source in the sense of having its origin in electromagnetic vibrations of the ether. While electromagnetic waves may be generated of numerically the same length as sound waves, yet the former are in the ether while the latter are disturbances of a material substance, air, which causes sound through a mechanical action on the tympanum of the ear. It is true that etheric vibrations cause the sensations of light and heat, but their action is a molecular not a mechanical one.

ELECTROLYSIS BY ALTERNATING CURRENTS.

The point brought forward by Drs. Bedell and Crehore in another column has a bearing on the question of electrolysis by alternating currents. It is known that in some cases the two carbons of alternating current arcs are consumed at unequal rates, and the explanation offered is that this naturally follows where the form of the current curve is unsymmetrical. The same reason would account for electrolysis under the same circumstances, and such electrolysis has also been noted. Should this explanation be true, and it seems to be entirely reasonable, it follows that unsymmetrical alternating currents are more dangerous than if symmetrical. An application of the principle might be usefully made by designing alternators for electrocution purposes, to generate unsymmetrical currents, thus adding to the effect on the criminal.

FLY-WHEEL ACCIDENTS.

In this issue we present some further contributions to the subject of fly-wheel accidents which has been so exhaustively discussed in our columns—one by Prof. Sharp, of the City and Guilds of London Technical College and the first section of another by Mr. W. Stuart Smith. Prof. Sharp's system of fly-wheel construction is an exceedingly interesting one, and while it seems to present some mechanical difficulties in securing the necessary rigidity, these have doubtless received full consideration from the inventor. We await with interest the promised account of the practical working of the wheel, which, in the interest of engineering science, we trust will be as successful as anticipated by the inventor. Mr. Smith discusses the subject in his usual forcible manner and does not hesitate to take issue with some of the principles which have been generally accepted as well-founded. As the matter under discussion is one of prime importance, we continue the offer of our columns to those who can add to its value.

MULTIPHASED POWER TRANSMISSION.

In another column we print an interesting article from the pen of Mr. Ralph D. Mershon, which develops a branch of multiphased transmission that has before been scarcely touched upon. While the statement by Mr. Mershon is correct that there is a saving of 25 per cent. in copper in favor of the three-phased system over the independent two-phased system, the comparison, it should be borne in mind, is quite different if the common return-wire-two-phased system is considered. It has been shown in our columns that for a given amount of energy transmitted at a given loss and with an equal stress on the insulation, there is, on the basis of effective E. M. F., with three-wires used in each case, an economy in copper in favor of two-phased currents of 3 per cent.; while if equal maximum stresses on the insulation be considered, there is an economy of copper of 94 per cent. in favor of three-phased currents. The first case differs further from the second through the fact that the saving in the

former is the same whether effective or maximum E. M. F. is considered. This, however, is a matter aside from the main points dealt with by Mr. Mershon, in regard to which we shall be pleased to hear from those who have had opportunities to study them.

THE STORAGE BATTERY INDUSTRY.

As we look back on the development of the electrical industries during the past fourteen years—a commercial development unparalleled in the history of the world—we find one singular circumstance connected with it, which is that aside from some promotors and inventors, but few have profited from a business that from its vastness should have been an incomparable source of wealth. When we come to examine into the causes we find that perhaps the principal one has been the stupendous litigation, which will render the period almost as memorable from a legal as from an electrical standpoint. No branch of the industry has suffered more in this respect than that relating to storage batteries, in which not only have millions of money been lost but the industry itself throttled for years. Owing to the legal impediments encountered at every step the slight commercial progress made by this branch in comparison with other electrical ones, became a matter of reproach, and even led to the storage battery itself falling into an undeserved repute. It is, therefore, with satisfaction that the new era will be regarded which has been just inaugurated by the consolidation of warring storage battery interests, referred to in another column, and which we trust will result in the fulfilment of the sanguine hopes of those who have so long looked for the storage battery to take its merited place among the electrical industries. While it is much to be regretted that the peace between the hostile interests was not sooner established, the present is yet an opportune moment, for the field of usefulness is now well prepared in many respects. For central and power station work the opening is already a wide one, and it is not at all improbable that the future may see the storage battery an essential part of every station equipment. The same in a somewhat less degree is true of its use with isolated plants, and he would be rash indeed who would maintain that storage battery traction contains no possibilities, notwithstanding its lack of success in the past. Developments in other directions can now also be attempted without the fear of an untimely halt being called. Not the least benefit of the industry being placed on an assured basis is that its success will result in again attracting inventors to the field, and perhaps some of the theoretical considerations recently put forth by German electrochemists may thereby be worked into practical realizations.

THE LIGHT OF THE FUTURE.

Dr. Palaz in his work on photometry remarks that to improve the optical efficiency of light sources "there should only be produced "such vibrations of the ether as are susceptible of affecting the "retina," or vibrations having a wave length between .81μ and .36μ —μ being 0.001 mm. The problem thus is not a complicated one as far as its statement is concerned, and when we learn that the greater part of the energy of the voltaic arc is lost in heat at a wave length of only 1.16 μ we see that the question of producing "cold light" resolves itself into one of reducing this wave length less than 50 per cent. Unfortunately it too often happens that what to Nature is but a minute interval in the course of a phenomenon, is yet the entire extent that the powers of man are permitted to affect. In the present instance there is, however, a growing hope that human endeavor will finally succeed in so directing the motion of the ether that the numerically slight reduction necessary in the wave length of vibratory energy may be obtained. In this connection it is interesting to compare the various sources of light with relation to the proportion of their vibratory energy utilized in producing the sensation of light. As we know the amount of energy contained in a given weight or volume of oil and gas and also the corresponding amount of light produced, it is a simple matter to express the unit of light given by these illuminants in watts. We thus find that an oil flame requires about 42 watts of energy per candle power emitted, and the ordinary gas jet 93 watts; with the incandescent lamp and voltaic arc these figures are 3.1 and 0.8 watts respectively. Accepting the efficiency given by Weber of the incandescent lamp at normal candle power,—one per cent.—the optical efficiencies of the above sources are therefore .07, .03, 1.0 and 4 per cent. respectively, while Dr. Palaz quotes the efficiency of the magnesium lamp at 15 per cent. and that of the Geissler tube at 32.7 per cent. The gas flame, therefore, dissipates 99.3 per cent. of its energy in vibrations that do not produce the sensation of light, and the maximum dissipation occurs at a wave length of 1.6μ, the corresponding maximum of the voltaic arc being 1.16μ. We see from the above that high optical efficiencies are obtained in three ways,—by a high degree of incandescence of carbon and of magnesium and by vibratory motion set up in the ether by an electric discharge through a Geissler tube. With carbon as a material we cannot expect a greater efficiency of the arc lamp than at present, as it has been shown that the temperatures of the crater cannot be increased (unless under pressure) since it now corresponds to the point of vaporization, while the incandescence of the carbon filament has also probably reached a practical limit. The only chance of improvement in this direction, then, seems to lie in the utilization of a material which may be raised to a higher temperature and incandescence than carbon, or, like magnesium, will at a given temperature give off a much larger number of luminous rays than carbon. The experiments of Tesla and Ebert in producing the requisite rate of etheric vibration by electrical instead of thermal means contain the greatest promise, even if the efficiency of the Geissler tube is merely attained in a practical light, and there is hope that it may extend much further than this. Finally, it is not impossible that we may even solve the mystery of the light of the fire-fly, which would be the most perfect solution of the problem; Langley finds that all of the radiations emitted from this source have a wave length between .45 μ and .65 μ and therefore the optical efficiency is probably 100 per cent.

Electric Welding Patents.

The suit brought by the Thomson Electric Welding Company, of Lynn, Mass., against the Two Rivers' Manufacturing Company, of Wisconsin, has been terminated by the entry of a decree sustaining the validity of the fundamental patents of Elihu Thomson on electric welding and apparatus therefor, and adjudging that the defendants have infringed the same.

Several weeks ago a preliminary injunction was granted against the Two Rivers' Manufacturing Company by Judge Seamans, who rendered an opinion sustaining these patents. The case was carefully tried on behalf of the defendant and all known defences were before the court. The judge found, however, that the patents were valid and were not affected by any of these defences, and granted an injunction.

The Two Rivers' Manufacturing Company has settled for the past and taken a license from the Thomson Electric Welding Company on its regular terms.

A Criterion of Dullness.

An English contemporary remarks that when a member of a scientific society advances to the blackboard and says, "Let P be a body of perfect conductivity and of any shape," carefully drawing it and shading it, "immersed in an infinite isotropic dielectric of inductive capacity K, and r and s_1 two infinitely small charges," also carefully drawn, "moving with the velocities v and v_1," then we know things are going to be a little dull.

Electrical Muscle Making.

A Viennese electrical journal quotes a recent note published in The Electrical World (Aug. 11, see also Nov. 24, p 544), and makes the suggestion that hereafter cattle raisers will find that an electrical machine is more important to them than the finest pasturage.

Nature's Method.

The London *Electrician* says that nature, so far from objecting to fractional indices, really protests against jumping from stepping stones of squares to cubes and higher powers, and prefers to wade with dignity through the stream.

Absorption of Storage Battery Patents.

One of the most important electrical deals of recent years was consummated at Philadelphia last week, through which all of the fundamental storage battery patents were acquired by the Electric Storage Battery Company, the owner of the chloride battery patents.

The Faure group of patents (including those of Swan, Sellon, Voickmar and Griscom) were acquired from the Accumulator Company, the Brush-Julien patents from the Consolidated Electric Storage Company and the Brush patents from the General Electric Company. This ends absolutely the extensive litigation in which the various companies had become involved and the Electric Storage Battery Company will henceforth be the sole manufacturer of storage batteries under the patents acquired.

No official statement has as yet been made in regard to the future relations with the companies from whom the various patents were purchased, but it is reported that there will be a friendly coöperation. The Electro Dynamic Company, which has always been closely connected with the Accumulator Company, will continue to manufacture dynamos and appliances for storage battery plants and it is reported that the General Electric Company will exert its influence in favor of the interest now in possession of the patents.

The incorporation papers of the Electric Storage Battery Company were amended on Dec. 6, at Trenton, N. J., so as to increase the capital of the company from $10,000,000 to $13,500,000. It is stated that a proposed issue of stock to the amount of $500,000 has already been underwritten at $50 per share by a syndicate of well-known financiers.

A Peculiar Phenomenon.

BY M. W. HASSAN.

In experimenting with a rectifier supplied with a constant current supplied from two cells of dry battey, I have often noticed that the magnetism working against the resistance offered by a tension spring, produces a series of harmonics as the spring is gradually tightened and the reverse when loosened. Although the sounds are not as well defined as are musical notes and some of them often very "unmusical," still there seems order enough to detect a substantial scale of sound extraneous and distinct from the mechanical noise or "buzz" of the instrument.

To be more explicit, this rectifier is a combination of two magnets, one fixed, the other vibrating in the same magnetic field producing induction interacting end to end, not concentric; it also acts as a reciprocating motor, while its simplest function is that of an interrupter. A short time since I noticed that it produced quite clearly the musical note of "G," which I could hear quite plainly in a certain position; but when the ear was placed in another position the sound vanished; this struck me as peculiar, for it was a sound effect pure and simple, and should be heard in all positions the same relative distance from the instrument. With a change of but a few inches in any direction from this certain point the note was lost, seeming to drop out of audition without any diminution or gradual drop in intensity. I pondered on the subject some time and wondered if the time had come when the human ear could hear something that was not sound, say one foot away from the place where it certainly was sound, for it must have made itself known through the tympanum, and its apparent volume was such as to warrant hearing it across a room.

It can be accounted for in this way, that it was a very minute sound and that some phase of induction produced a microphone effect which exalted the note so that the ear was treated to a normal rendition.

This quasi-explanation or generalization, however, did not satisfy the writer, and not until your last issue of December 1 was received was there any more light flashed on this dark subject. In that issue, however, there is in the Digest an extract regarding "refraction and dispersion rays of electric force," wherein it is stated that "the rays proceeding from a Hertzian primary conductor may be analyzed into a spectrum by a prism made up of resonators." Although this statement does not definately settle the fact of the existence of such a thing as the "magnetic spectrum," still it affords some comfort to know that interested parties are looking for such a spectrum in the ultimate hope of finding it. The rectifier above referred to is so constructed as to approximate to what might, by a little forcing, be called four resonators or, in reality, four loop paths which terminate in steel springs, platinum faced, which act as contacts but may on approach or retreat accommodate static discharges; in fact, there is sparking between them when in operation.

Thinking that the note might proceed from the tension spring, which is a very short steel spiral, the same was muffled and the note survived, apparently showing it to be a genuine induction effect.

I was familiar with the principle of Elisha Gray's harmonic telegraph and have read much in your valuable paper about harmonics as a destroyer of efficiency in light and motor circuits, but never had an opportunity to see a practical illustration of any such effects except such as here described with a very crude apparatus.

Is it not possible that in a magnetic field, distortion of the lines of force may produce vibrations in the ether which are analogous to air waves and that sound may be conveyed to the auditorium, not through tympanum but by the condenser effect of the human body?

A case in point is that of a metallic point near a static machine "blowing" the flame of a candle, the flame being distorted identically as if a current of air was blown against it; the air is stationary but the stream of ether proceeding from the metallic point completely counterfeits an air effect. The eye cannot detect any difference between an air or ether effect, both acting the same on the optic nerve; following out the same analogy, why cannot the auditory nerve be deceived as to whether its impression comes from the ether or the air?

Consumption of Alternating Arc Carbons.

BY FREDERIC BEDELL AND A. C. CREHORE.

In the early part of 1892 our attention was called to the fact that the two carbons in an alternating arc light are in some cases consumed unequally. The same current and quantity of electricity flow through each and the phenomenon seems scarcely expected. In a paper presented before the American Institute of Electrical Engineers, June 7, 1892 (Transactions, Vol. IX., p. 370; see also Alternating Currents, p. 170), we showed that with an unsymmetrical alternating current, the energy expended during successive semi-periods may not be equal, although in all cases the quantity of electricity which flows is the same. This, we suggested, "may afford an explanation for the fact that in many cases one carbon of an alternating current arc lamp is consumed more rapidly than the other, depending upon the way it is connected up." Exception having been taken to this statement, a fuller explanation of its significence may be in place. In a recent communication to the London *Electrician* (Nov. 9, 1894), we have discussed this question and from this we quote in part.

It is well known that in an arc lamp supplied with the direct current, the consumption of the two carbons is unequal, notwithstanding the fact that the same current and the same quantity of electricity pass through both. The positive carbon is consumed the faster, and for the purpose of illustration we will assume that the positive is consumed twice as rapidly as the negative carbon. This being the case, consider the alternating arc lamp, with carbons A and B supplied with an unsymmetrical alternating current, such that the *energy* in successive semi-periods is not equal, being greater when A is positive. If the frequency is 130 complete periods per second, then one-half of a period lasts 1-260th of a second. During the first 1-260th of a second, when A is positive, we may regard the lamp as a direct current lamp, and suppose that A now loses 6 units of carbon. During the same time B therefore loses one-half as much, or 3 units, as in a direct-current lamp. During the next 1-260th of a second the current reverses and B is now positive. Under the assumption that this semi-period is unsymmetrical with the first, so that the energy is less now than during the first semi-period, of course B will lose less carbon than A did before. Suppose B now loses 4 units. Regarding the lamp as a direct-current lamp during this semi-period, A will lose one-half as much as B, or 2 units. Evidently during the whole period, or during the 1-130th part of a second, A loses $6 + 2 = 8$ units, while B only loses $3 + 4 = 7$ units, and so on during every successive period A loses more than B. It therefore follows that this is a possible explanation of the phenomenon, known as the result of experiment, that in many cases the two carbons in an alternating arc lamp are consumed unequally.

Concentric Wiring.

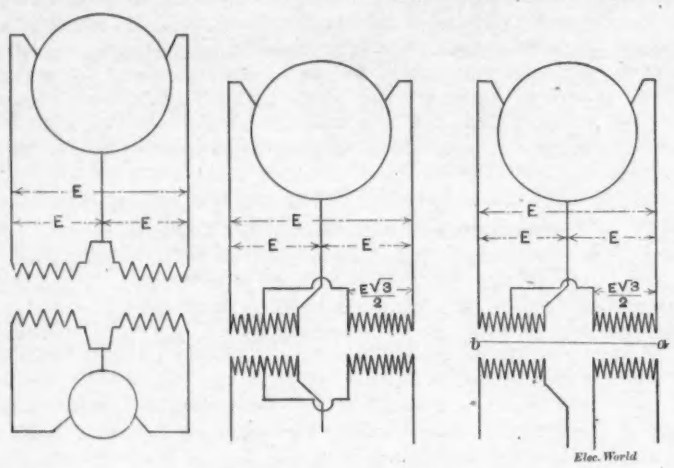
In a letter to the London *Electrical Review*, Messrs. J. D. F. Andrews & Co. state that recent experiments tend to show that whether concentric wire consists of iron or copper, the self-inductance is practically the same, and if an ordinary copper concentric cable is used in place of the iron armor, section for section, the results are the same in every case.

Some Notes on Multiphase Power Transmission.

BY RALPH D. MERSHON.

Until lately, one of the chief claims of the two-phase system of power transmission to superiority over the three-phase has been the fact that with the former transformation of power could be effected with two instead of three transformers. Now, however, there are several well know methods of transforming the power of three-phase circuits by the use of two transformers, though, as will be shown, at some sacrifice as regards the capacity and efficiency of the transforming apparatus.

In what follows it is assumed that the transformers are always worked at the same E. M. F. and current and therefore at the same loss. In obtaining the ratios given below, the losses in the transformers are neglected and the consequent small error is in the direction of making the ratios slightly less than they should be.



FIGS. 1, 2 AND 3.

Fig. 1 shows one method of connecting two transformers for transforming from three-phase to three-phase. If the current in each lead is C, the output of the pair of transformers is, neglecting the losses, $EC\sqrt{3}$. The same two transformers if used on a two-phase circuit at the same E. M. F. and current will have an output of $2\,E\,C$.

$$\therefore \frac{\text{Output 2-phase}}{\text{Output 3-phase}} = \frac{2\,E\,C}{\sqrt{3}\,E\,C} = 1.155$$

or the output of the transformers will be about 16 per cent. greater on a two-phase than on a three-phase circuit. If the three-phase loss is p per cent., the two-phase loss is $\frac{p\sqrt{3}}{2} = .867$ per cent. Hence if the efficiency three-phase 97 per cent. the efficiency two-phase is 97.4 per cent.

Fig. 2 shows another method of connection for three-phase to three-phase transformation. As before, with a current C in each of the three-phase leads, the output is $E\,C\sqrt{3}$. When used on a two-phase circuit at the same E. M. F. and current the output of one converter is $\frac{E\,C\sqrt{3}}{2}$ and of the other $E\,C$. The output of the two is therefore $E\,C\left(\frac{\sqrt{3}+2}{2}\right)$, or the

$$\frac{\text{Output 2-phase}}{\text{Output 3-phase}} = \frac{E\,C\left(\frac{\sqrt{3}+2}{2}\right)}{E\,C\sqrt{3}} = 1.077.$$

That is, the output of these converters on a two-phase circuit is about 8 per cent. greater than on a three-phase circuit. If the loss three-phase is p per cent. the two-phase loss is $\frac{p\,2\sqrt{3}}{\sqrt{3}+2} = .928$ per cent. If the three-phase efficiency is 9 per cent. the two-phase efficiency is 97.2 per cent.

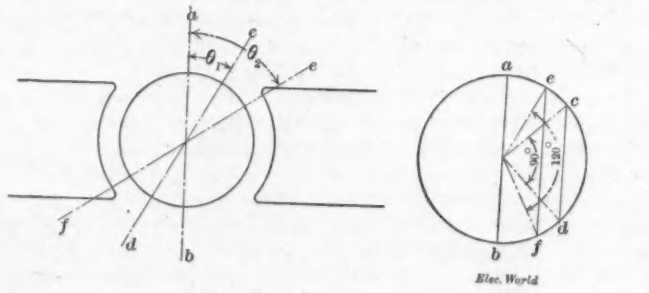
Fig. 3 shows the connections for transforming from three to two-phase with two transformers. If the current in each three-phase lead be C the output of the transformers is $E\,C\sqrt{3}$. The output of the transformer a when used on a two-phase circuit is $\frac{E\,C\sqrt{3}}{2}$. If the transformers have the same total copper loss and are designed as they should be with equal losses in the primary and secondary coils, the primary of a, the secondary of a and the secondary of b, will have equal amounts of copper. Since the primary of b must have $\frac{2}{\sqrt{3}}$ times as many turns as that of a, the wire in b must have $\frac{2}{\sqrt{3}}$ times the section of that of a in order that the copper losses in the two shall be equal. The primary of b has therefore $\frac{2}{\sqrt{3}} \times \frac{2}{\sqrt{3}} = \frac{4}{3}$ as much copper as that of a. If b is to be run on a two-phase circuit, there must for best results be equal amounts of copper in its secondary and primary. Dividing then, this ⅓ excess of primary copper between primary and secondary, we shall have a converter in which each coil has 7-6 as much copper as the secondary of b originally had. Since the output of a transformer coil at a constant voltage and copper loss varies as the square foot of the amount of copper, and since the output of the secondary of b was originally $\frac{E\,C\sqrt{3}}{2}$ the ouptut of b as thus changed is $\frac{E\,C\sqrt{3}}{2}\sqrt{7/6}$ when run on a two-phase circuit. The combined output of the converters on a two-phase circuit is therefore

$$E\,C\frac{\sqrt{3}}{2}\sqrt{7/6} + \frac{E\,C\sqrt{3}}{2} = E\,C\frac{\sqrt{3}\,(1+\sqrt{7/6})}{2}$$

$$\frac{\text{Output 2-phase}}{\text{Output 3-phase} - \text{2-phase}} = \frac{E\,C\sqrt{3}\,(1+\sqrt{7/6})}{E\,C\sqrt{3}\times 2} = 1.042$$

or the two-phase output will be about 4 per cent. greater than that on a three-phase-two-phase circuit. If the three-phase-two-phase loss is p per cent., the two-phase loss is $\frac{p\,2}{1+\sqrt{7/6}} = .96\,p$ per cent. If the three-phase-two-phase efficiency is 97 per cent., the two-phase efficiency is 97.1 per cent.

The advantage claimed for the three-phase over the two-phase system of transmission is economy of copper, since with the same stress on the line insulation the former requires only ¾ as much copper as the latter for transmitting the same power at the same loss. In ordinary practice, however, the stress on the insulation of the line is of small importance as compared with that on the insulation of the apparatus delivering the power to line, since the difference in cost of installing and maintaining a line for say 5,000 volts and a line for 1,000 volts is small as compared with the difference in cost of the generating or transforming apparatus for the same voltages. Therefore, unless the stress on the line insulation is identical with that on the insulation of the apparatus delivering power to line, the line E. M. F. is not the proper basis for comparing the two systems. When the power is delivered to line from converters or from an open coil armature the stress on the insulation of line and the insulation of apparatus is identical, but when a closed coil armature is used these stresses are not always identical. In a closed coil armature the effective E. M. F. (square root of mean square) to whose maximum the insulation stress in the armature is due, is the same as the effective E. M. F. of a two-phase circuit but greater than that of a three-phase circuit lead off from this armature. If the effective E. M. F. for whose maximum the armature must be insulated is E, the effective E. M. F. of a two-phase



FIGS. 4 AND 4a.

circuit from that armature is E and that of a three-phase circuit is $\frac{E\sqrt{3}}{2}$. If e be any effective voltage and K a constant such that $\frac{K}{e^2}$ is the copper required for the transmission by a two-phase system of a given power at a given loss, $\frac{3}{4}\frac{K}{e^2}$ is the copper required for a three-phase system under the same conditions. Putting in the values $e = E$ and $e = \frac{E\sqrt{3}}{2}$,

$$\text{Copper, Two-phase} = \frac{K}{E^2}$$

$$\text{Copper, Three-phase} = \frac{\frac{3}{4}K}{\left(\frac{E\sqrt{3}}{2}\right)^2} = \frac{K}{E^2}$$

That is, for the same stress on the insulation of a closed coil armature feeding the line direct, the same amount of copper will be required for the transmission of the same power at the same loss whether a two-phase or three-phase system be employed.

There is no doubt that a great deal of power transmission will be accomplished by means of a closed coil generator feeding direct to line, thus avoiding converters with their losses and impairment of regulation and taking advantage of the high efficiency and output of a closed coil armature. The point made above therefore becomes of some importance, since it shows that for the same cost of generating apparatus we may have all the advantages of a two-phase system as regards regulation, efficiency and transformation (where it is desired to reduce the voltage at the receiving stations) and yet sacrifice nothing as regards economy of copper.

The relation given above as existing between the two-phase and three-phase E. M. F.'s from the same or similar closed coil armatures may be demonstrated as follows: Let Fig. 4 represent the closed coil armature of a two-pole generator whose coils give a sine wave E. M. F. The lines *ab cd* and *ef* bounding the angles θ_1 and θ_2 are supposed stationary. A pair of leads attached at the ends of a diameter will have between them the greatest effective E. M. F. the armature can give; call this effective E. M. F., E. When this diameter coincides with *ab*, E will have its maximum value, $E\sqrt{2} = e$. Let the number of coils included by the unit angle be n. Then the number of coils in series over an angle $d\theta$ is $\frac{nd\theta}{2}$. If these coils $\frac{nd\theta}{2}$ are at any instant in an angular position θ, the E. M. F. in each coil at that instant is $k\cdot\sin\theta$ and the total E. M. F. of the series $\frac{nd\theta}{2}$ is $\frac{nd\theta}{2}k\sin\theta$. Therefore the E. M. F. in the series of coils included at any instant between the angles θ_1, and θ_2 is

$$e' = \frac{nk}{2}\int_{\theta_1}^{\theta_2}\sin\theta\, d\theta = \frac{nk}{2}\Big[-\cos\theta\Big]_{\theta_1}^{\theta_2} = \frac{nk}{2}\Big[\cos\theta_1 - \cos\theta_2\Big]$$

when $\theta_1 = 0$ and $\theta_2 = \pi$, $e' = e$

$$\therefore e' = e = \frac{nk}{2}\Big[1+1\Big] = nk \quad \therefore e' = \frac{e}{2}\Big[\cos\theta_1 - \cos\theta_2\Big]. \quad (A.)$$

When $\theta_1 = 30°$ and $\theta_2 = 150°$ we have the condition for maximum E. M. F. of one phase of a three-phase circuit.

$$\therefore e' = \frac{e}{2}\Big[\tfrac{1}{2}\sqrt{3} + \tfrac{1}{2}\sqrt{3}\Big] = \frac{e\sqrt{3}}{2}$$

Therefore, the maximum E. M. F. of the two-phase circuit is e, that of the three-phase is $\frac{e\sqrt{3}}{2}$ and the effective voltages, since they bear to each other the same relation as their maxima, are, as stated above, E and $\frac{E\sqrt{3}}{2}$. It follows from equation (A) that if a circle be drawn as in Fig. 5 with a diameter $ab = E$, the chord subtending an arc equal to that included between the points of attachment to the armature of any two leads will represent either the maximum or effective electromotive force between those leads accordingly as E represents the greatest instantaneous electromotive force or the greatest effective electromotive force the armature is capable of giving.

Referring to Fig. 5 for an angle π between leads the E. M. F. is $ab = E$; for an angle $\frac{\pi}{2}$, $cd = E\frac{\sqrt{2}}{2}$; for an angle $\frac{2\pi}{3}$, $ef = \frac{E\sqrt{3}}{2}$, etc. Also, if there be n leads symmetrically connected to the armature, the E. M. F. between any two adjacent ones is $E\sin.\frac{\pi}{n}$ and this is, as just explained, the maximum or effective E. M. F. according to the significance of E.

It may be mentioned incidentally that equation (A) gives the E. M. F. between any two points on the commutator of a direct current machine, whose coils generate a sine E. M. F. wave when E is the E. M. F. between the main brushes and the points are at any angles θ_1 and θ_2 measured from the diameter of commutation.

Railways in Europe.

It is stated that there are at present more miles of electrical railways in the city of Boston than in the whole of Europe.

Practical Notes on Dynamo Calculation—XXI.

BY ALFRED E. WIENER.

39. Relative Permeances in Dynamo-Electric Machines.

(a.) Principle of magnetic potential.

In taking the magnetic potential between two polepieces of opposite polarity as unity for calculating the relative permeances in dynamo-electric machines, the potentials between various points of the magnetic circuit depend upon the number of electromagnets magnetically in series between two consecutive poles of opposite polarity.

If, as is the case in the majority of types, there are two magnets between any north pole and the next south pole of the machine, then the magnetic potential between two points, x and y (Fig. 57) of the magnetic circuit separated by but one electromagnet, is $= \frac{1}{2}$; and two points, y and z, of the magnet-frame not separated by any exciting coil, have no differenee of magnetic potential, their potential $= 0$. If the circuit consists of but one electromagnet, or of several magnets magnetically in parallel, then the magnetic potential between any two leakage surfaces of opposite polarity is $= 1$, *i. e.*, equal to the difference of magnetic potential between the polepieces.

The observance of this general principle enables us to bring all the relative permeances into proper relation to each other, and we can now apply formulæ (112) to (118) to the cases of a dynamo.

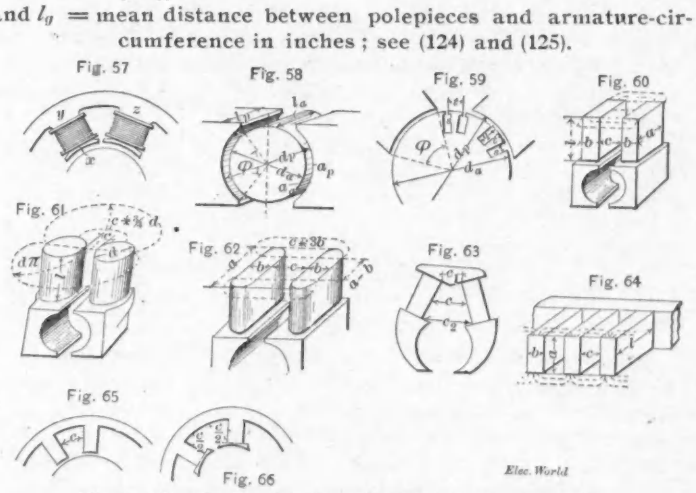
(b.) Relative Permeance of the Air-Gaps (P_1).

According to (112) the relative permeance of the air-gaps can be expressed by

$$P_1 = \frac{A_g}{l_g}, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (119)$$

if A_g = area of gap-spaces, *i. e.*, the mean of pole area and surface of armature core in sq. inches, see formula (120),

and l_g = mean distance between polepieces and armature-circumference in inches; see (124) and (125).



FIGS. 57, 58, 59, 60, 61, 62, 63, 64, 65 AND 66

the *mean area* of the gap-space for any armature facing poles opposite its *outer* periphery is given by the equation:

$$A_g = \tfrac{1}{2}(a_a + a_p) \times \tfrac{1}{2}(l_a + l_p) \ldots\ldots\ldots (120)$$

where a_a = half perimeter of armature-core, in inches;

for *smooth* cores (Fig. 58): $a_a = \frac{d_a \times \pi}{2}$, ... (121)

for *toothed* cores (Fig. 59): $a_a = \frac{d_a \times \pi}{2} + n \times q$ .. (122)

d_a = diameter of armature core, in inches;
n = number of teeth;
q = depth of slots, in inches;

a_p = circumference of half the polepieces, in inches;

$$a_p = d_p \times \pi \times \frac{P \times \phi}{360°}, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (123)$$

d_p = diameter of bore of polepieces, in inches;
p = number of pairs of magnet poles;
ϕ = angle embraced by each pole;
l_a = length of armature core, in inches;
l_p = length of polepieces in inches.

The *mean length* of the field-path, in both gaps, according to chapter 48 is:

For *smooth* armatures: $l_g = k_{12} \times (d_p - d_a)$, ... (124)

and for *toothed* armatures: $l_g = k_{12} \times (d_p - d_a) + \frac{s \times q}{s + t}$, ... (125)

d_a = diameter of armature-core, in inches; d_p = diameter of bore of field, in inches; } Figs. 58 and 59.
s = width of slots, in inches; t = width at top of teeth, in inches; q = depth of slots, in inches; } Fig. 59.
k_{13} = factor of field deflection; see Table LVI in chapter 48.

Combining formulæ (120), (121), (123) and (124), and formulæ (120), (122), (123) and (125) respectively, the relative permeance of the air-gaps, for smooth and for toothed armatures, respectively is obtained.

For *smooth* armatures we have:

$$P_1 = \frac{A_g}{l_g} = \frac{\frac{1}{2}\left(\frac{d_a\pi}{2} + d_p\pi \times \frac{p \times \phi}{360^\circ}\right) \times \frac{1}{2}(l_a + l_p)}{k_{13} \times (d_p - d_a)}$$

$$= \frac{\frac{1}{8}\left(d_a\pi + d_p\pi \times \frac{p \times \phi}{180}\right)(l_a + l_p)}{k_{13} \times (d_p - d_a)} \quad \ldots\ldots\ldots\ldots (126);$$

and for *toothed* armatures:

$$P_1 = \frac{A_g}{l_g} = \frac{\frac{1}{2}\left[\left(\frac{d_a\pi}{2} + n \times q\right) + d_p\pi \times \frac{p \times \phi}{360^\circ}\right] \times \frac{1}{2}(l_a + l_p)}{k_{13} \times (d_p - d_a) + \frac{s \times q}{s + t}}$$

$$= \frac{\frac{1}{8}\left(d_a\pi + d_p\pi \times \frac{p \times \phi}{180} + n \times q\right)(l_a + l_p)}{k_{13} \times (d_p - d_a) + \frac{s \times q}{s + t}} \quad \ldots\ldots\ldots 127.$$

For armatures revolving *outside* of a magnetic field, (*inner-pole type*), in the denominator of formula (125) the order of the diameters d_a and d_p is to be reversed, as in this case, d_a, the *internal* diameter of the armature-core, is larger than the diameter of the field.

If poles are situated *interior* as well as *exterior* to the armature, the mean of the outer and inner gap-areas has to be taken, by applying formula (120) to the inner diameter as well as to the outer diameter of the core; and instead of $(d_p - d_a)$ the sum of the outer and inner gaps is to be substituted.

In case of armatures, finally, facing the poles in the *axial* direction, (*flat ring type*), the gap area, if polepieces are used, is the mean of half the pole-area and the ring-area of the armature core; and if no separate polepieces are employed, is practically equal to half the sectional area of the magnet-cores. The mean length of the path is the difference between the axial pole-distance and the axial breadth of the armature-core, multiplied by the factor of field-deflection.

(*c.*) *Relative average permeance across the magnetic cores* (P_2).

Since in dynamo-electric machines the magnet cores, with their ends averted from the armature, are magnetically joined by special "*yokes*," or by the frame of the machine, forming the magnetic return circuit, the magnetic potential between these joined ends is practically = 0, while the full magnetic potential is availing between the free ends towards the armature. The *average* magnetic potential over the whole length of the magnet-cores, therefore, is one half of the maximum potential, and the *average relative permeance*, consequently, one half of that which would exist between the cores if they had the same magnetic potential all over their length.

For the varions forms of magnetic cores by means of formulæ (113) to (118) respectively, we therefore obtain the following relative average permeances:

1. Rectangular Cores.

The permeance between two rectangular magnet-cores, Fig. 60, is the sum of the permeances between the inner surfaces which face each other, formula (114), and between the end-surfaces which lie in the same plane, formula (115), and therefore the average permeance is

$$P_2 = \frac{a \times l}{2c} + \frac{b \times l}{c + b \times \frac{\pi}{2}}, \quad \ldots\ldots\ldots\ldots (128)$$

where a, b, c and l are the dimensions of the cores, in inches, as in Fig. 60.

2. Round Cores.

According to formula (117) we have in this case (see Fig. 61):

$$P_2 = \frac{1}{2} \times \frac{d\pi \times l}{c + \frac{3}{4}d} = \frac{d\pi \times l}{2c + 1.5\,d} \quad \ldots\ldots\ldots\ldots (129).$$

3. Oval Cores.

For oval cores, Fig. 62, the permeance path consists of two parts, a straight portion between the inner surfaces, and a curved portion between the round end-surfaces. Combining, therefore, formulæ (114) and (117) we obtain:

$$P_2 = \frac{(a - b) \times l}{2c} + \frac{b\pi \times l}{2c + 1.5\,b}, \quad \ldots\ldots\ldots\ldots (130).$$

4. Inclined Cores.

If the cores, instead of being parallel to each other, are set at an angle, Fig. 63, the distance, c, in formulæ (128), (129) and (130) respectively, has to be averaged from the least and greatest distance of the cores:

$$c = \frac{c_1 + c_2}{2} \quad \ldots\ldots\ldots\ldots (131)$$

5. Multipolar Types.

In case of multipolar dynamos of p pairs of poles, the total permeance across the magnet-cores is $2p$ times that between each pair of the cores. In calculating the latter, it has to be considered that while the permeances across two opposite side-surfaces does not change by increasing their number, the leakage across two end-surfaces is reduced, half of the lines leaking to the neighboring core at one side, and half to that on the other side.

For *rectangular* cores, therefore, we have, with reference to Fig. 64:

$$P_2 = 2p \times \left(\frac{a \times l}{2c} + \frac{\frac{1}{2}b \times l}{c + b \times \frac{\pi}{4}}\right) = p \times \left(\frac{a \times l}{c} + \frac{b \times l}{c + b\frac{\pi}{4}}\right); \quad (132);$$

for *round* cores, according to formula (118):

$$P_2 = 2p \times \frac{d\pi \times l}{2(2c + .6\,d)} = p \times \frac{d\pi \times l}{2c + .6\,d}; \quad \ldots\ldots\ldots (133),$$

and for *oval* cores:

$$P_2 = p \times \left(\frac{(a - b) \times l}{2c} + \frac{b \times \pi \times l}{2c + .6\,b}\right) \quad \ldots\ldots\ldots\ldots (134).$$

In multipolar machines for c the smaller of either the mean distance between two magnets, Fig. 65, or twice the mean distance between magnet-core and yoke, Fig. 66, is to be taken.

(*d*) *Relative permeance across polepieces* (P_3).

The amount of leakage across the end and side-surfaces of the polepieces, that is, across all their surfaces not facing the armature core, depends upon the slope of the polepieces, and upon the design of the machine with reference to an actual iron surface (bed-plates) near the polepieces.

By the principle of the magnetic potential the *actual* permeance, according to formula (112), in this case, is also the "*relative*" one, as the magnetic potential between two polepieces of opposite polarity is unity.

The respective relative permeance for the various shapes of polepieces can, therefore, easily be deduced by means of formulæ (113) to (118), chapter 38.

(*e*) *Relative permeance between polepieces and yoke* (P_4).

According to the general principle of calculating relative permeances, the magnetic potential between polepieces and yoke is to be taken $= \frac{1}{2}$, with reference to the potential between two polepieces of opposite polarity. For the yokes serve to join two magnet-cores in series magnetically, and are therefore separated from the polepieces by but one electro-magnet. If the yokes join the magnets in parallel, then they usually serve as polepieces also, and must be considered as such in leakage calculations.

Since the amounts of the leakages in the various paths are proportional to their permeances, in dynamos having an external iron surface near the polepieces, most of the leakage takes place between the polepieces across that external surface; and in such machines the leakage from the polepieces to the yoke is comparatively small.

The value of the relative permeance between polepieces and yoke, for every, individual case, consequently, is obtained by taking one half of the respective actual permeance, as calculated from formulæ (112) to (118) respectively.

Note.—The end of Chapter 36, page 598, should read: "Prof. Forbes' logarithmic formulæ* heretofore employed, etc."

* Silv. P. Thompson, Dynamo Electric Machinery, 4th Edition, page 186.

Formula (113), page 599, should read:

$$P = \frac{\frac{1}{2}(A_1 + A_2)}{c + \frac{a_1 + a_2}{2} \times \frac{\pi}{2} \times \frac{a}{180^3}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (113).$$

In paragraph referring to Fig. 54, sub (e), page 599, $y = \frac{a}{4}$ should be replaced by $y = \frac{d}{4}$.

In section (f) of Chapter 38, read $c + \cdot 3\,d$, instead of $C + \cdot 3\,d$.

(To be continued.)

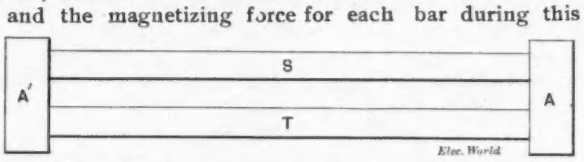
A Method of Determining Induction and Hysteresis Curves.

BY FRANK HOLDEN.

If a magnetic circuit of uniform cross-section be composed of parts of different permeability, and magnetomotive forces be applied uniformly along the length of each section having values inversely as the permeabilities of the sections to which they are applied, there will then be no external field from this arrangement and the magnetomotive forces will be easily calculable if all the dimensions be known, as shown in Gray's "Absolute Measurements in Electricity and Magnetism," Vol. II., page 281.

Perhaps the simplest arrangement of this is that shown in the accompanying cut, in which A and A' are two blocks of soft iron drilled so that the two rods, which are uniformly wound from block to block, may fit well into them. Means for varying and measuring independently the current in each coil is provided, and the coils are so connected that if the coil for the bar S magnetizes from A to A' then the coil for T magnetizes from A' to A. A sensitive magnetometer is placed so as to best show any external field between A and A'.

Knowing the induction curve of S, then by this arrangement may that of T be found. For by a variation of the currents the condition may be brought about such that there is no leakage between A and A', and then the inductions in the two bars are necessarily equal and the magnetizing force for each bar during this con-



A METHOD OF DETERMINING INDUCTION AND HYSTERESIS CURVES.

dition is calculable from the distance between the blocks, L, and the number of turns N, and the currents in the coils C, $\mathfrak{C}$ being $\frac{4\pi N C}{10 L}$.

By reference to the induction curve of S, the induction value is found for S and consequently for T. The magnetomotive force being calculated, one point in the curve for T is determined, and the others may be similarly found. During the adjustments of the currents, they must be frequently and simultaneously reversed to prevent any indefiniteness because of hysteresis.

By a somewhat similar procedure, the hysteresis curve of T for a certain maximum induction may be found if that of S for the same induction be known. The current for S is made to equal that needed to produce the maximum induction, determined by reference to the known curve and while both are being reversed, the current for T is varied until there is no leakage. The value of this current and reference to the known curve determine the highest point of the desired curve. The current for S is then decreased to a certain value and that of T decreased until again there is no leakage. The magnetomotive force for each bar is then calculable and the induction found by reference as before to the known curve. This is continued until the currents arrive at the same numerical value but reversed, when one side of the curve will be determined.

Although it complicates calculation a little, yet it is possible to use bars of different cross-sections and so give the apparatus greater range. The bars may be used of such a length that the reluctances at the joints do not have an appreciable effect, so much so that sheet iron is easily tested in this manner.

Based on this magnetic arrangement, it is theoretically possible to build an apparatus that will draw the desired curve and integrate it at one operation so that the hysteresis loss may be read directly without calculation.

Where Professors Unbend.

Even the professors, according to a London contemporary, cease to be professional at the friendly meetings of the Physical Society and do not treat their audience like a class of naughty boys.

Electrical Power Transmission—IV.

BY LOUIS BELL, Ph. D.

Power Transmission by Continuous Currents.

23. Up to the present time by far the largest part of electrical power transmission has been done by continuous currents. All the earlier plants were of this type, and even now, when transmission by alternating currents, polyphase and others, is pushing rapidly to the front, the older type of apparatus is still being installed on an extensive scale, and on account of the large number of plants now in operation, even if for no others reason, will probably remain in use for a long time to come. New power transmission plants, both here and abroad, are more and more frequently installed with alternating currents, and in many cases this practice is almost

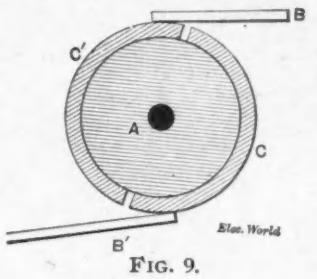


FIG. 9.

absolutely necessary, but there still remain many cases wherein the conditions are as well or better met in the old-fashioned way.

Chief among these may be mentioned electric railway work, which in America alone probably requires not less half a million horse power in generators and motors. Certain difficult work at variable speed and load, and many simple transmissions over short distances are at present best handled by continuous current machinery. As alternating practice advances many, perhaps all, of these special cases will be eliminated, but we are dealing with the art of power transmission as it exists to-day, and hence continuous current working deserves very careful consideration.

24. The broad principle of the continuous current generator has already been explained, but its modifications in actual work are important and worthy of special investigation. In a general way, continuous currents are almost always obtained by commuting the current obtained from a machine which would naturally deliver alternating currents. This process is, however, by no means as simple as Fig. 9 would suggest. With a two-part commutator the resulting current, although unidirectional, would necessarily be very irregular owing to the fact that the total current drops to zero at the mo-

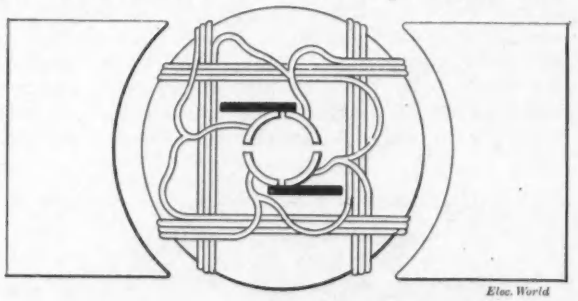


FIG. 10.

ment of commutation. Such a current is ill fitted for many purposes, and the commutator would be rapidly destroyed by sparking if the machine were of any practical size.

To avoid these difficulties, the number of coils on the armature is increased and they are so interconnected that, while each coil has its connection to the outside current reversed as before, when its electromotive force is zero, the other coils in which the E. M. F. still remains in the right direction continue in circuit unchanged. In this way the E. M. F. at the brush is the sum of the E. M. F.'s of a number of coils, each of which is reversed at the proper moment. The number of commutator segments is increased proportionally to the number of coils and the commutator thus becomes a comparatively complicated structure. The result, however, is that the total E. M. F. of the armature only varies by the variation in a single coil. The nature of this modification is shown in Fig. 10 which shows a four-part commutator connected to a four-coil armature.

An eight-part winding modern type is shown in Fig. 11. Tracing out the currents in this will give a clear idea both of a typical winding and of the process of commutation.

In commercial machines the number of individual coils and of commutator segments often exceeds 100, but the principle of the winding is the same. Nearly all the early dynamos had several turns of wire per coil, as in Fig. 10, but at present, in all large machines at least, one turn constitutes a complete coil. This extreme sub-division is to avoid sparking at the commutator, which becomes destructive if the current be large and the E. M. F. per commutator segment great.

If each coil generates a considerable voltage there is even under the best conditions of commutation a strong tendency for sparks to follow the brush across the insulation between segments or even to

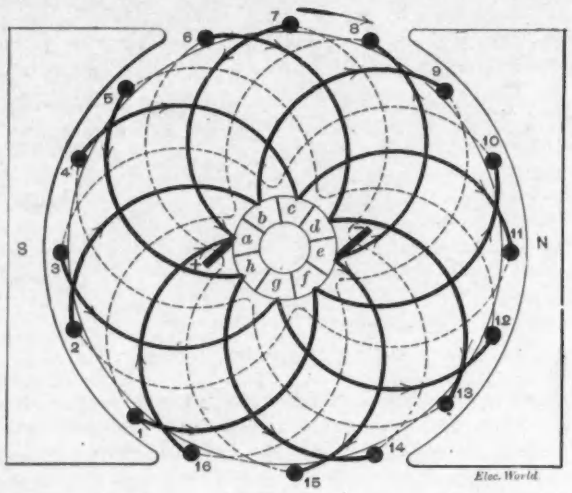


FIG. 11.

jump across this insulation elsewhere. As this goes from bad to worse and rapidly ruins the commutator, every precaution has to be taken against such a contingency. The E. M. F. generated by each coil is kept low by sub-dividing the winding, and in large machines it is the rule that the E. M. F. of a single loop is quite all that can safely be allotted to a single commutator segment.

Present good practice indicates that for generators for lighting up to 100 or 150 volts the voltage between brushes should be subdivided so that it shall not exceed three or four volts for each segment between the brushes. For 500 or 600 volt machines it should not exceed 10 or 12 volts, while for dynamos of still higher voltage it may rise to 20 volts or more. The reason for these different figures is that the destructiveness of the spark depends on the amount of current which is liable to be involved. On a low voltage commutator intended for heavy currents, even very moderate sparking may gnaw the segments seriously while the spark of an arc machine in spite of its venomous appearance may do very little harm, as the maximum current in the whole bar will not exceed 8 or 10 amperes. Consequently the voltage per bar in such cases is sometimes 50 or more, while in very large incandescent machines and in

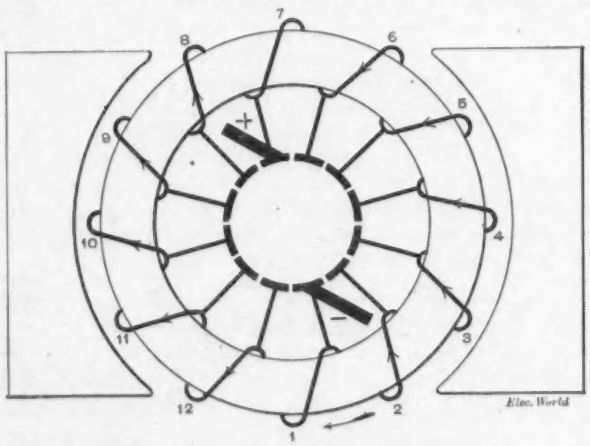


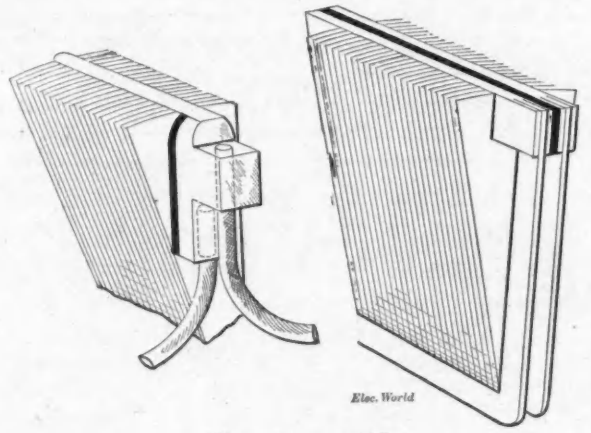
FIG. 12.

those designed for electrolytic purposes the E. M. F. per bar is often less than 2 volt, or even 1 volt.

25. Windings like those of Fig. 10 and 11 are of the so-called *drum* type in which each convolution extends around the whole body of the armature, either diametrically or nearly so. Another sort of armature winding frequently used, although less now than formerly, is the *Gramme* so called from its inventor. Here the iron body of the armature is, instead of being cylindrical, in the form of a massive ring of rectangular cross section. The windings are looped through and around this ring, fitting it firmly and closely. Fig. 12, which shows in diagram a winding in ten sections, furnishes a good example of the Gramme construction. There may be one or several turns per coil, as in drum windings. These two general types of windings are used with various modifications in nearly all continuous current dynamos. Each has its good and bad features. The Gramme winding makes it very easy to keep down the voltage per segment, inasmuch as for each wire under induction there is a commutator bar, while in the drum form there is but one bar for two wires. It is also mechanically solid even when wound with small wire, and no two adjacent wires can have a considerable voltage between them, thus making it easy to build an armature for high E. M. F. On the other hand, the drum winding gives a very compact armature of easy construction, and the magnetism induced in it is less likely to disturb that of the field.

In the small machines once usual the Gramme type was preferred for high voltages on account of the ease with which it could be repaired, while the drum was liked for its simplicity of mechanical construction as a whole and excellent efficiency as an inductor. In modern practice the differences between these types have become much less marked. With large units, particularly of the multipolar form now usual, the drum winding is as easily insulated as the Gramme, for with the winding now used in such cases there need be no considerable voltage between adjacent wires, and repairs are of very infrequent occurence. In fact, the drum winding can be made quite as accessible as the other, and is on the whole cheaper and simpler. Almost the sole advantage of the Gramme (*or ring*) winding is that of low voltage per commutator bar. Mechanically, too, there is less difference than formerly, for the coils are in both types frequently bedded in slots in the iron of the armature core.

26. It must be noted that the armature of the modern dynamo, unless



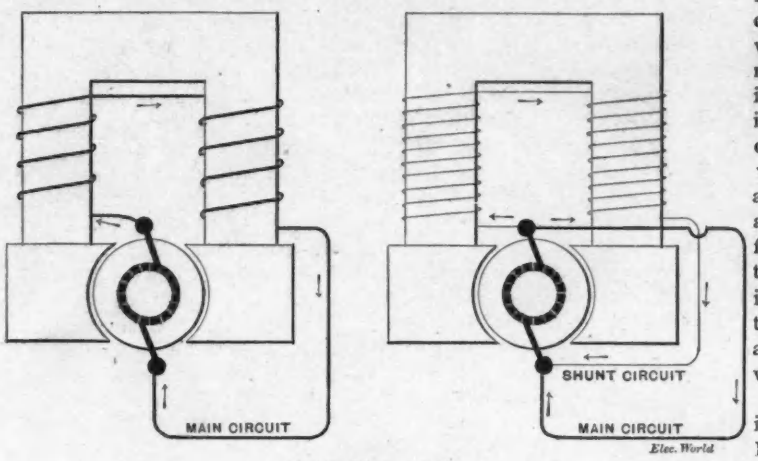
FIGS. 14 AND 13.

of small size or unusually high voltage, is seldom wound with wire in the ordinary sense of the word. Instead, the conductors are bars of copper, often of sections rectangular rather than round, and generally lacking any permanently attached insulation. Whatever the winding, the conductors on the armature face are enclosed in close fitting tubes of mica and specially treated paper or the like, and then put in place on the armature core or in more or less completely closed channels cut in it. If on the core surface, the bars are not generally insulated on the exterior surface at all. If the armature core be slotted, the insulating material is preferably put in position first and the bar put in afterwards. As to the rest of the winding it is completed by connectors of copper strip or rod soldered to the face conductors and insulated in a substantial manner. Thus each convolution, whether of ring or drum winding, is composed of from two to four pieces.

A typical modern ring winding is shown in Fig. 13. It well exemplifies the construction above mentioned and in this case the insulated faces of the exterior conductors form the commutator of the machine. Such a construction of course includes iron clad armatures and is best fitted for a machine having a field magnet inside the ring armature. A similar arrangement which avoids the above limitations, uses the side connectors of the ring as commutator segments. The general principle, however, is the same, whether the commutator forms part of the winding proper or is a separate structure.

An iron clad drum winding of typical character is shown in Fig. 14. Here the exterior bars are fitted into thoroughly insulated slots in the core, and wedged firmly into place by insulating wedges.

Sometimes the bars themselves are shaped so as to act as wedges. In either case the bars are held almost as solidly as if they formed an integral part of the core. The commutator in these windings must be a separate affair. Fig. 14 shows well the nature of the winding, with its slotted core, dense insulation, and massive bars—in this example one per slot. The end connectors lie in a pair of reverse spirals, one outside the other, and separated by firm insulation. The relation of these connectors to the rest of the winding is illustrated in Fig. 11.



FIGS. 15 AND 16.

Between the modern drum and ring armatures it is difficult to discriminate. Both have been successfully used in dynamos of the largest size, but the iron clad drum is in the more general use. It is rather unusual to find a standard generator of recent build and of 100-kw or more output with a regular wire wound armature, and the most of them have some modification of the bar windings just described.

27. We have briefly reviewed here the armature windings at present in general use and may now pass to the various windings employed for the field magnets. These are, in continuous current dynamos, almost always connected and supplied with current from the armature winding, thus making the machines self-exciting. As the armature is turned the action begins with the weak residual, magnetism left in the field magnets, and the current set up by the small E. M. F. thus produced is passed around, gradually strengthens the magnets, building them up to full strength. If this residual magnetism is very feeble, as may happen when it is knocked out of the iron by rough handling or the continual jarring of a long

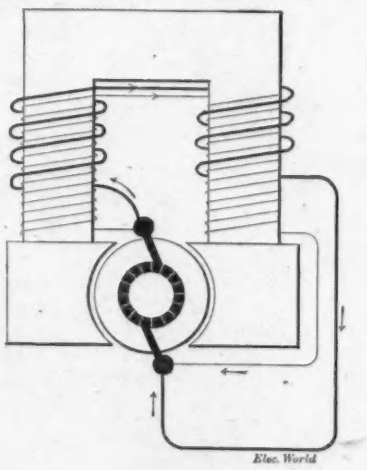


FIG. 17.

journey, it is sometimes quite difficult to get the machine into action.

The simplest form of field winding, and the one which was most extensively used at first, is that in which the current from one of the brushes passes around the field magnet coils on its way to or from the external circuit of the machine, as shown in Fig. 15. This *series* winding possesss more than one advantage. It consists of a comparatively small number of convolutions of rather large wire and so is cheap to wind; it is, for this same reason, less liable to injury and easier to repair when injured; and what is of particular importance, whenever the series dynamo is called upon for more current, the magnetizing power of the fields is raised by the increase, thus increasing the electromotive force. This property, once considered a disadvantage, becomes of great value in modern windings adapted for the purpose. As the generation of E. M. F. at the start depends entirely on the residual magnetism, series wound machines do not "build up" full voltage very easily unless the resistance of the outside circuit is fairly low, thus giving the current a chance.

The common shunt winding shown in Fig. 16 almost describes itself. The brushes are, independently of the exterior circuit, connected to magnetizing coils of fine wire. Although such a field winding is slightly harder to construct and maintain, it produces a magnetic field that is relatively free from any actions in the working circuit of the machine. So long as the E. M. F. at the brushes is unaffected by changes of speed, the field will be quite steady except as a very large current in the exterior circuit may reduce the voltage available for the field by causing a loss of voltage in the armature. If the armature resistence be very small, there will be almost a constant E. M. F. at the brushes except as the current flowing in the armature may produce a magnetization opposed to the shunt field. For a considerable time, then, the shunt winding was always used when a constant E. M. F. was required. At the same time, it permits the E. M. F. to be varied, if desired, with a very small loss of energy, by the simple expedient of putting a variable resistance in circuit with the field magnets.

As the principles of dynamo construction became better known, it was apparent that the above method of getting a constant E. M. F. was rather expensive. To build an armature that would carry a heavy current without noticeable loss of voltage and to enclose it in fields so strong as to be disturbed only in a minute degree by the magnetizing effects of such currents, is a task requiring much care and a great amount of material. Even if this difficult problem were solved, the constant voltage would be at the brushes of the machine and not at the load where it is wanted.

An easy way out of these difficulties is found by considering an important property of the series wound machine just mentioned, *i.e.*, the rise of E. M. F. as the load on the external circuit rises. If now one takes a good shunt wound dynamo and adds to the field magnets a few *series* turns wound in the same direction as the shunt, the result is as follows: At no load, the voltage at the brushes is that due to the shunt alone. As the load comes on this would naturally fall off owing to the loss of voltage from armature resistance and reaction. The series turns, however, at this juncture strengthens the field and thus compensates for these losses. This is the *compound winding* now very generally used. It is shown in diagram in Fig. 17. Ordinarily the series turns are more than would be needed for merely compensating the losses due to armature resistance and reaction, so that the voltage at the brushes under load will rise enough to make up for the increased loss in the line due to carrying heavier current.

Machines thus *over-compounded* five or ten per cent are in quite common use.

(To be continued.)

Inventors and Inventions.

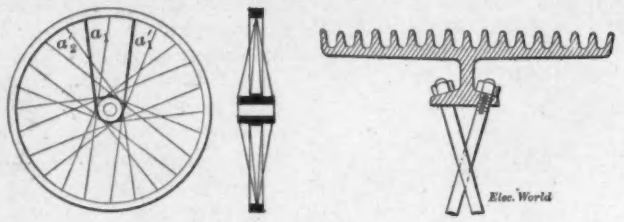
In a recent address, Mr. Alexaner Siemens said that it is a popular superstition that the inventors are heaven made, and that they can produce useful novelties to order in any branch of manufacture where a want exists, if only their attention is drawn to it. "The history of the invention of the steam engine," he added "is a well known illustration of the point I wish to emphasize. According to the popular version, Watt, a small boy, saw the lid of a tea kettle move up and down, when the water was boiling, and this suggested to him the construction of a steam engine. As a matter of fact, Watt made himself acquainted with what had been done before (a point altogether ignored in the popular version), and had to work very hard before he brought his invention to a successful issue. His example is typical of the true method of progress, and we may generally say that in order to approach a problem with the most certain prospect of success it is necessary:—(1) To define, as accurately as possible, the want that exists, or the particular object that is to be attained. (2.) To be well acquainted with the scientific principles which come into play. (3.) To know how the want is met, or the object attained in practical life. (4.) To find out what proposals have been made by others in the same or in a similar case. A careful attention to these requirements will prevent much disappointment and waste of energy, as will be obvious to all of you without further explanation."

Fly-Wheel Accidents.

BY ARCHIBALD SHARP.

I have read with interest the discussion on fly-wheel accidents which has been going on in your journal. The conclusion drawn from the discussion, that "cast iron fly-wheels are engineering absurdities, and that the governor is probably the most important piece of apparatus in a power house," may be true with reference to the existing types of large cast iron fly-wheels; but I hope to show below that a fly-wheel with a cast iron rim can be made with a sufficient margin of safety to meet heavier demands than have yet been made upon them.

In considering the stresses to which a fly-wheel is subjected, a clear distinction must be made between (1) the stresses existing when the wheel is running *uniformly* at a high speed; and (2) the stresses imposed by a sudden alteration of the speed. In the first case, if the power is not taken by belts or ropes from the rim.



Figs. 1, 2 and 3.

the stresses are simply called into existence by the centrifugal forces due to the speed, presuming there are no initial stresses on the wheel while at rest. If the rim could revolve freely without constraint at the arms, as would be the case if the arms fitted loosely into radial holes in the rim, the centrifugal force would produce a uniform circumferential tension on the rim, given by the formula, $\frac{s\,v^2}{g}$ s being the weight of one foot, length of rim one square inch in section and v the linear velocity of the rim in feet per second. At a speed of 100 feet per second, this stress only amounts to .469 tons per square inch, and this low stress even the much maligned material cast iron may be safely entrusted to bear. But the fact that the arms are rigidly fastened at the rim interferes with the above condition of affairs; and each rim segment, under the action of the centrifugal forces and the radial constraint of the arm, is practically in the condition of a beam uniformly loaded and supported at its middle point (if the rim joints be midway between the arms), or at its two ends (if the rim joints be at the ends of the arms). The stresses due to this bending, combined with the existing initial stresses, must be relatively far higher than the circumferential stress, and probably account for the breakup of many a fly-wheel.

If w be the radial centrifugal forces per foot run, and l the length of a segment, then the maximum bending moment on a rim segment is proportional to wl^2. Thus keeping the section of the rim constant, the maximum bending stresses on the rim due to centrifugal force are proportional to the square of the number of arms, and a means of improving the design of a cast iron fly-wheel is suggested.

If the power be taken off from the rim by ropes or belts, in addition to the above stresses there will be a constant tangential effort transmitted from the arms to the rim, which may increase the maximum bending stresses.

In case (2) when the fly-wheel is being accelerated or retarded by a diminution or increase of load, a considerable tangential effort is transmitted by the arms from the nave to the rim. This tangential effort will in many cases be very much greater than that due to the steady driving at full load. The bending stresses on the arms due to this effort may be greater than they can carry and fracture will occur. If a fly-wheel bursts from this cause alone, centrifugal stresses being low, it is possible that all the arms may be broken and the rim left intact. Is any such case known?

The use of cast iron for fly-wheel arms seems to me to be utterly out of place; in no other important structures subjected to shock are large cast iron members subjected to transverse stress; even the use of cast iron for beams of short span carrying steady loads is being gradually discarded, while engine beams of cast iron are things of the past.

Prof. Thurston remarks "that the charge of steam just taken into the cylinder is sufficient to accelerate its speed to the danger point with a weak and faulty wheel." Now the fly-wheel ought to be made sufficiently powerful to allow the full power of the engine to be expended in simply accelerating its speed, and yet take sufficient time to arrive at the danger point to allow the attendant reasonable time to shut off the steam. This seems to me to be the last and safest resource, as any automatic apparatus, however carefully designed, may be liable to derangement at the critical moment. In such a case a few minutes, even seconds, are valuable, and with a *powerful* fly-wheel the increase of speed will be so slow as to afford the necessary time.

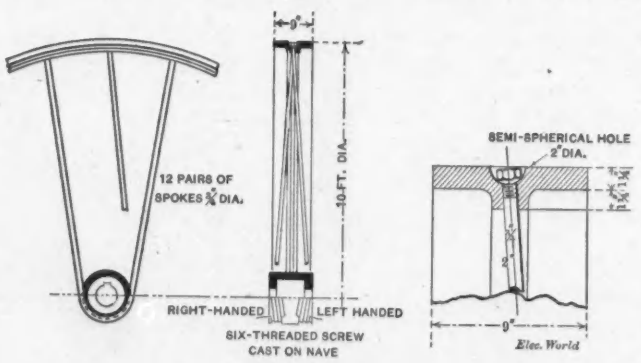
Mr. Field suggests better proportioned and heavier fly-wheels. I presume by heavier he means more powerful wheels; with the design of fly-wheel described below the "powerfulness" is obtained not by an increase of weight but by an increase of speed of rim.

Mr. H. Ward Leonard suggests that the fly-wheel should have a solid web made of boiler iron, and a rim similarly built up of boiler iron riveted together. Such a wheel might be safe, but I am afraid that its cost would be prohibitive.

I trust the following design will satisfy Mr. G. T. Hanchett, as a realization of the ideal fly-wheel, though it is not built in the manner he suggests.

A description of my fly-wheel has already been given, on your side of the water, in a paper* by Mr. John Galt, C. E., before the Canadian Association of Electrical Engineers, on "Improved Regulation by Fly-wheel Accumulatros." The distinctive features of the design are illustrated in Figs. 1 and 2. The nave or hub of the wheel is suspended from the rim by a series of steel loops, one loop forming a *pair* of spokes. One loop or pair of spokes is shown thickened in Fig. 1. The ends of the spokes are fastened to the rim by nuts. There is absolutely no fastening of the spokes to the nave beyond that due to friction. The spokes are spread laterally in the manner usually adopted in bicycle wheel construction. The part of a loop in contact with the nave is formed spirally so that all the ends of the spokes on one side of the middle plane begin contact with the nave at the same distance from the middle, and the other ends leave the nave nearer the middle plane. In the wheel shown in Figs. 1 and 2, there are twelve pairs of spokes, that is, six pairs on each side of the middle plane; so that if the parts in contact with the nave lie in grooves, these grooves will form practically a six-threaded screw. Fig. 3 is a design of the section of rim for a rope fly-wheel, and Fig. 4 is a design for a high speed fly-wheel for a gas engine at a lighting station. This wheel construction is applicable to all kinds of built up wheels; from bicycle wheels—for which it has been tested over a period of two years—up to the largest class of fly-wheels. In the heaviest class of rope or belt pulley fly-wheel a considerable proportion of the weight, up to in many cases 20 per cent., is in the nave and arms, which, moving at a low linear speed, contribute little or nothing to the storage capacity. The cost of machining, fitting and erecting these arms is considerable, so that my wheel with its light steel spokes, with little or no workmanship required on them, will compare favorably in price with the wheels of the older type.

Again, the rim being supported by numerous spokes, there are practically no bending stresses on the rim, so that a wheel with cast iron rim can be safely run at a much higher speed than is attempted at present. The energy stored varying with the square



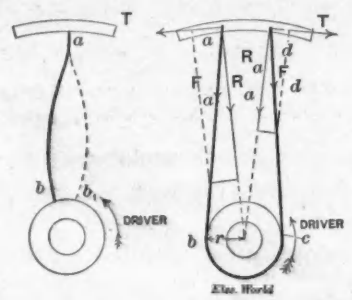
Figs. 4 and 4*a*.

of the speed, increasing the speed is a much better means of increasing the powerfulness of a fly-wheel, than increasing the weight.

A fly-wheel built on this system must not be confounded with a wrought iron pulley of the usual type, with radial spokes. In wrought iron pulleys—and in fact with cast iron wheels with radial arms—the arms or spokes, which are straight when the wheel is at rest, will each be bent (as shown exaggerated at *ab* (Fig. 5) when the effort is being transmitted from the nave to the rim, in the direction of the arrow. If the direction of the driving effort be reversed, and the rim overrun the nave, the spoke will be bent as

*Abstracted in The Electrical World, September 29, 1894.

shown by the dotted line *ab*. Thus the radial spokes constitute a slightly flexible coupling between the rim and the nave, so that the rim may be moving with practically uniform velocity, while the fluctuations of velocity of the nave may be considerable. In my patent fly-wheels and pulleys the action of the spokes is entirely different. Fig. 6 is a sketch showing one pair of spokes in its relation to the nave and rim. When the wheel is at rest, or rotating with uniform velocity, the tensions on the two ends of the spokes are equal. When effort is being transmitted from the nave to the rim in the direction of the arrow, the pully F_a on the portion *ab* of the pair of spokes is a little greater than the initial pull; while the pull F_d on the portion *dc* is a little less. The difference between F_a and F_d is taken up by the frictional grip of the portion *bc* on the nave. The difference $(F_a - F_d)$ multiplied by r, the radius of the nave, gives the twisting moment transmitted per pair of spokes. Another method of considering the action is the following: The forces F_a and F_d acting on the rim at *a* and *d* respectively, may be resolved into radial and tangential components T_a R_a and



FIGS. 5 AND 6.

T_d, and R_d respectively. The radial components R_a and R_d have no effect in accelerating or retarding the motion of the rim, so the resulting force accelerating the rim is $(T_a - T_d)$ per pair of spokes.

The initial tension on the spokes, due to screwing up the nuts, produces an initial circumferential compression in the rim. At a certain speed of rim the centrifugal forces will just neutralize this compression, and the circumferential stress on the rim will be zero. At a higher speed the circumferential stress will be tension. Owing to the existence of this initial compression a velocity of 200 feet per second will be quite safe with a rim of cast iron. The centrifugal tension in the rim due to its own weight at this speed is 1.87 tons per square inch; it will be reduced by the initial tension on the spokes, the amount of reduction depending on the number of spokes.

A rim of mild steel may be safely run at 300 feet per second; at this speed one ton weight of rim stores 94.85 horse power minutes; while for a variation of speed 5 per cent. above and 5 per cent. below the average, an available energy of 18.97 horse power minutes per ton weight of rim is obtained. Such a high speed fly-wheel would be most conveniently placed on the dynamo shaft. An engine of 740-hp. with a ten-ton fly-wheel running at 300 feet per second, if allowed to run *full power with no load* would take one minute to increase its speed by one-third. This would give the attendants ample time to shut down the steam stop valve in case of accident; and even if no attendant was at hand and the speed still further increased, the wheel would first give way by the spokes and rim increasing in size, the rim would ultimately press against the bottom of the pit in which it runs, and thus form an effective brake which would prevent further increase of speed and further damage.

The above design is confidently offered as a solution of the fly-wheel problem. I hope to be able to give some figures in the course of a few weeks, as to the relative performances of a gas engine driving a dynamo with ordinary fly-wheels, and with a lighter high speed fly-wheel of my construction.

Another Competition of Self-Contained Vehicles.

A French contemporary states that it is proposed to organize a new competition of self-contained carriages, and that the comfort of passengers will not be studied as in the case of the *Petit Journal* contest, but that awards will be made to those competitors whose vehicles attain the highest speed on a long route. The minimum distance to be traversed is 620 miles; the start will be made from Paris, to which city the carriages will return; and the vehicles admissable to the competition must be operated either by an electric motor, a steam engine, or a petroleum or similar motor. An organizing committee has already been formed, and it is intended to arrange for the competition taking place next year.

Fly-Wheel Accidents.

BY W. STUART-SMITH.

Mr. Coykendall, in his communication to The Electrical World, Oct. 13, took the ground that in some cases the wrecking of fly-wheels is due to a sudden strain thrown on them by the closing of the circuit breaker with a short circuit on the line. This statement has called forth an extended discussion by many eminent engineers. Some of the participants agree that such strains are sufficient to wreck the wheel, while others deny it, but no one has denied that closing the circuit breaker under the conditions named will cause the strains as claimed; nevertheless there is some ground for doubt as a consideration of the conditions will show. With the circuit breaker open the engine is running light and cutting off steam almost at the beginning of the stroke; the speed is at a maximum, say 2 to 4 per cent. above the normal, and the amount of stored energy in the fly-wheel is at a maximum. When the circuit breaker is closed there is certainly an increased load which requires to be taken up, but as the engine is running with a minimum amount of steam it is not in condition to take up this load, nor can it do so until through a reduction of speed the governor is enabled to alter the position of the eccentric sufficiently to materially increase the admission of steam. If the circuit breaker is closed when the piston is just beginning its stroke, full pressure will be upon the piston, but in this position it can exert no turning effort, and hence the engine cannot take up the load. If the closing occurs when the engine is on the half center the position would be right for the engine to take up the load, but it is unable to do so because it has no steam. As the engine cannot take up the load either at position of maximum pressure on the piston or maximum turning effort, it is evident no blow tending to wreck the wheel can come from the engine. As under the circumstances the engine cannot supply the power required to take up the load, it is necessary to have recourse to some other source of power for the purpose, and this is found in the stored energy of the fly-wheel, which, as above stated, is running at from 2 to 4 per cent above the normal. Thus when the circuit breaker is closed the stored energy of the fly-wheel must supply the initial power required to take up the load, and this withdrawal of stored energy will gradually reduce the speed from the high speed of light load to the speed of normal running. During the reduction of speed the power developed by the engine will gradually increase and it will transfer to itself the load which was at first assumed by the fly wheel. This transference will not be sudden but will be extended over the time required to reduce the speed, so that at no time will there be anything in a nature of a blow on the engine.

If the fly-wheel was not used as the driver the stored energy of the rim would have to be transmitted through the arms, which would in consequence be somewhat strained, but if the fly-wheel at the same time acted as driver the only strain on the arms would be that required to reduce by 2 to 4 per cent. the momentum of the piston, connecting rods and other moving parts, and it hardly seems possible any one can claim that this could have any injurious effect on the arms.

With the fly-wheel acting as a driver there will be some strain on the rim, and if the belt covers, say two-fifths of the circumference, the entire strain will at first come on this two-fifths, and if the rim is not sufficiently stiff it is possible that the wheel might be distorted sufficiently to cause the rim to break by transverse strain, but if the rim was stiff enough to retain its shape this action could not occur. With a stiff rim there is still another action tending to produce rupture. The retarding effort on the rim would be confined entirely to the two-fifths of the wheel covered by the belt, while the remaining three-fifths, being entirely free from the influence of the belt, would tend by its inertia to keep up its speed with the result that a tensile strain would be set up which would have a maximum value just at that point where the slack side of the belt was tangent to the face of the wheel. As the total reduction of speed would not be more than 2 to 4 per cent., and as to reduce the speed by this amount an appreciable time would be required, it hardly seems possible that closing the circuit breaker, under any conditions, can throw any dangerous strain upon the engine.

When, however, the circuit breaker opens there will be a different condition of affairs, as the engine will then be running with maximum steam and it might happen that the circuit breaker opened just as the crank was on the half centre, and with full boiler pressure (less the drop) in the cylinder. This would be the condition of greatest possible turning effort, and the instantaneous effort to increase the speed would be so great that there would be a strong tendency to shear the arms before inertia of the rim, armatures, etc., could be overcome.

Again, at the moment the short circuit occurs there would be a strain on the rim tending to cause it to collapse, as when the circuit breaker is closed with a short circuit on the line, and there would also be a strain on the arms tending to break them, because the tendency would be to check the speed of the engine at the time when it was putting forth its maximum turning effort. Thus when a shorter circuit occurs on this line and the circuit breaker opens, the arms receive two blows tending to break them transversely, and a strain comes on the rim tending to crush it, while at closing the cicruit breaker, the rim only receives the strain, and it is evident that Mr. Coykendall has laid great stress on the strain which is least dangerous.

Before the proportions of any piece of machinery can be properly fixed, it is of the highest importance that a careful study be made of the work it has to do, what strains it will be subjected to and how the straining forces are to be applied. In all works dealing with the proportions of fly-wheels, it is assumed that on the rim centrifugal force only will act while the only office of the arms is to transmit the driving power to the rim. This may possibly be true when the sole office of the wheel is to store energy during that part of the stroke when the engine is putting forth its maximum effort and supply energy when the engine is on or near the centers and capable of exerting little or no effort, *i. e.*, when its sole office is to act as a fly-wheel and steady the motion of the machinery, but when it at the same time must perform the double office of fly-wheel and driver a consideration of the conditions will show that the strains are by no means simple or the acting forces steady in the application, and it may be shown that the arms are subjected to other than transverse strains.

During the discussion which followed Mr. Coykendall's original communication to The Electrical World, it was repeatedly stated that wheels went to pieces on account of the tensile strains produced by the tangential component of the centrifugal force.

The fact that when a wheel goes to pieces the separate portions move forward in a tangential direction is no doubt responsible for this impression, which seems to be quite general.

A very little consideration will show that with a symmetrical

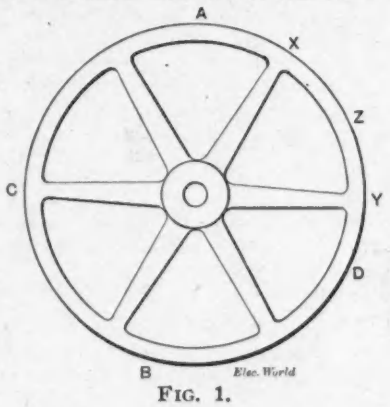


FIG. 1.

wheel having the rim intact and revolving at a uniform rate of speed, there can be no force acting to strain it in a tangential direction and there can be no tangential component of the centrifugal force. This is evident from the nature of centrifugal force. It acts in the direction of the radius, *i. e.*, normal to the surface at all points, and cannot have a component parallel to the surface. The mass certainly possesses inertia, but so long as the velocity remains unchecked there is no tensile strain on the rim. If, however, there is any force tending to retard a *portion* of the rim only the inertia of the remaining portion does exert a tensile strain at the point of application of the retarding force. During retardation or accellertion of the velocity of the wheel there will be forces tending to compress the rim forward of the arms and elongate behind them or half the space between the arms will be under compression and the other half under tension, but unless the retarding or accelerating force is applied very suddenly and the rim contains a flaw which makes a very weak point, these forces need not be taken into consideration.

If the rim suffers fracture, however, and a portion is no longer constrained to move out of the plane in which it was previously moving, centrifugal force is at once destroyed and its place taken by the force of inertia, which causes it to move forward in a tangential direction.

If the force tending to produce rupture was tangential, the rim strains would be tensile and would be very evenly distributed, but in reality the strains are unevenly distributed, as can be shown. The rim may be considered as a curved girder rigidly supported at regular intervals. In the sketch the space X Y between the two arms may be considered as a space over which the load is evenly distributed. In this case the load is the centrifugal force, the amount of which can be readily calculated for any groin wheel when the weight of the rim, diameter and number of arms are given the formula being $\frac{W V^2}{g r}$ when $W =$ the weight of the rim between two arms, $V =$ the linear velocity of the mean centre of the rim, $g =$ gravity, $r =$ the radius of the wheel.

The span is really an arch with the load applied from below instead of above, but a sufficiently close approximation to the strains will be obtained if it is considered as a straight span, and more especially as centrifugal force, which is the load, acts normally to the surface at all points instead of normal to the chord, as is usual with a loaded arch. The more nearly the arms are placed together and the larger the diameter of the wheel the more nearly the condition of a straight span is approximated. The greatest bending movement acts in the middle of the span, and is equal to $\frac{W L}{8}$ when $W =$ the total load on the span, or the centrifugal force for the span, and L is the mean curved length of the span. If a parabola be drawn having a chord equal to the length of the span on the curve, and the middle ordinate $c\,D = \frac{W L}{8}$, the other ordinates will represent the bending moments at other points of the span.

The maximum shearing stress at the point of support will be $\frac{W}{2}$ and the maximum deflection will be $\frac{W L^3}{76.8\,E\,I}$ when E is the modulus of elasticity, and I is the moment of inertia of the beam (or rim).

In order to see what these strains will amount to in practice, some data approximating to a wheel in actual use may be assumed. The fly-wheel of the Atlantic avenue power-house, Brooklyn, which burst about a year ago, was 18 feet in diameter and weighed 20 tons. The other data is lacking, but may be assumed as follows: number of arms, 12; revolutions, 90, giving a peripheral speed of 5,090 feet per minute. With a 20-ton wheel of that diameter, suppose the weight of the rim is 15 tons, and use this alone in calculating the centrifugal force. The rim would have a section of about 175 sq. in. The circumference being 56 feet and there being 12 arms, the length of one span or distance between arms will be 56 inches; hence the greatest bending moment will be $\frac{centrifugal\ \ force \times 56}{8} = 7 \times$ centrifugal force.

The weight of rim between two arms is 2,500 pounds, hence the centrifugal force of the span will be 62,700 pounds and $7 \times 62{,}700 = 438{,}900$ pounds, equals the maximum bending moment acting at the middle of the span. The maximum shearing stress $= \frac{62{,}700}{2} = 31{,}350$ pounds. Assuming 12,000 pounds as the resistance to shearing per square inch, the total resistance of the rim will be $12{,}000 \times 175 = 2{,}100{,}000$ pounds, or more than 60 times the shearing stress, hence it is evident that though the rim is subjected to shearing stress it is not much of a factor in the forces tending to wreck a wheel.

It is also evident that so long as the rim remains intact it cannot break close to the arms (if the arms are very strong) because the bending moment there is zero and shearing stress is the only one acting, and this, it is shown, is not worthy of consideration.

(To be continued).

Electric Motors in England.

Mr. Rankin Kennedy says that, like continuous current motors which can be used in ordinary continuous circuits, the alternating motor *would not* be much used even if it could, the cost of electrical energy being fatal to the use of motors on supply circuits. He adds that all the alternating motors wanted in Great Britain in a year would not keep one small firm from starvation, even if it secured the contract for the whole of them.

A Millionaire Author Criticised.

A writer of a review in one of our London electrical contemporaries, on John Jacob Astor's "A Journey Through Other Worlds," states that in spite of the preface of puerile platitudes he felt it his duty to read the book through, but he advises his readers not to do likewise unless they are prepared to treat it as a joke, and a weak one at that.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS

BY CARL HERING

ELECTRO-PHYSICS.

Effect of Cathode Rays on Salts.—A paper of Prof. Goldstein from the "Sitzungsberichte," of the Berlin Academy No. 38, is abstracted in the Lond. "Elec.," Nov. 23; he describes a curious effect which these rays exert on the color of certain salts. If potassium chloride be made to phosphoresce in radiation-tubes it quickly assumes a strong heliotrope shade and eventually becomes bright violet, which on heating becomes blue, and at high temperatures becomes white; the color gradually fades and disappears completely in about a week; in contact with water the salts lose their color at once; in a vacuum or in dry air the deep blue color of lithium chloride lasted for two months without apparent change; the cause of the phenomenon is unknown; chemical decomposition is unlikely. The author believes that during phosphorescence the particles of the salt have been made to take up positions and motions differing from those of the unaltered substances and that a physical modification of the salt has been brought about.

Luminescence of Glass.—Over one hundred years ago Beccaria observed that when vacuum-bulbs were broken in the dark a faint glow of light was produced in the place where the bulb lay, the effect being attributed to the rush of air against the glass walls. In a Physical Society paper abstracted in the English Journals, Nov. 23, Prof. J. J. Thomson concludes, after making numerous experiments that this phenomenon was due to the impact of glass against glass and not to the rush of air against the walls of a broken vessel.

An Electrode Sensitive to Light.—The Lond. "Elec. Rev.," Nov. 23, describes briefly an electrode which is claimed to be much more sensitive than any hitherto made; it was devised by Mr. Luggin and described in the "Zeit. f. Phys. Chem.;" it is made of "a plate of platinum coated with silver bromide and is then duplicated with a similarly coated platinum plate in an aqueos solution of bromide of potassium;" an exposure to diffused daylight was sufficient to cause a rise of potential of 0.5 volt; the rate of rise is not directly proportional to the intensity of the light, and it is lowered by previous exposure to light; continuous and intermittent lights of the same intensity do not produce the same effects and in general the plates do not remain constant in sensitiveness.

Actino-Electric Phenomenon.—A paper describing some researches by Messrs. Marechal & Rigollot is abstracted briefly in "L'Eclairage Elec.," Nov. 10; they also suggest a theory of the earth's magnetism, the earth currents, and the aurora borealis.

Electro-Magnetic Theory.—The long serial by Mr. Heaviside is continued in the Lond. "Elec.," Nov. 23; the present portion being the 59th part. The work of that writer is discussed editorially in the same issue.

Constitution of the Arc.—A French Academy paper by Mr. Thomas, describing some spectroscopic investigations, is published in "L'Elec.," Nov. 17.

MAGNETISM.

Effect of Magnetism on the Dimensions of Wires and Rings.—A Royal Society paper by Mr. Bidwell is reprinted in the Lond. "Elec. Eng.," Nov. 23. He describes the somewhat unexpected effects which were produced by carefully annealing the iron before using it; Joule stated that the elongation is greater in proportion to the softness of the metal, but the present writer shows that this is the reverse of the truth; he finds that after annealing, the maximum increment was less than one-fifth of its former value; and was reached with a magnetic force less than one-half of its former value; after heating it and dropping it into cold water a curve about midway between the others was obtained; in experimenting with rings he found that in one case the smallest current which caused any effect at all produced contraction, and there was no indication of the smallest extension. He concludes that as far as any changes of dimensions are concerned, an iron rod or ring is affected by annealing in very nearly the same manner as by tensile stress, a result which would hardly have been anticipated.

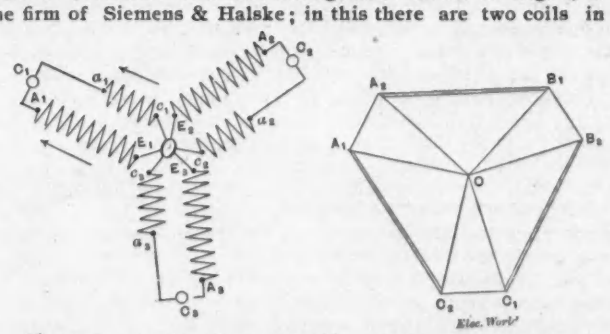
Curious Magnetic Phenomenon.—A phenomenon noticed by Mr. Lloyd is described and illustrated for the Lond. "Elec.," Nov. 23; he shows that when a magnet is broken and then joined or nearly joined again, there is not only a consequent point at the fracture, but there is what he calls an image or ghost of a similar consequent point symmetrically situated with respect to the general shape of the whole magnet, which appears as if it were an optical reflection; tightening the crack seems to make the image or "sympathy crack" more marked, while an air space in the fracture seems to destroy it; fine iron filings and a rather strong field are necessary to bring out the effects; (it appears to be limite to the iron of an electro-magnet); the effect is very remarkable and there seems to be no explanation of it.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Conductivity of Solutions of Salts.—A paper by Mr. Deguisne from the "Weid. Ann." vol. 52, p. 604, is abstracted in "L'Eclairage Elec.," Nov. 10. Dr. Lussana some time ago made the statement that salts have a maximum conductivity in the neighborhood of 4°; the present author describes some recent researches which he made, and from which he concludes that this is not the case.

DYNAMOS AND MOTORS.

Starting Three-Phase Motors.—In a long and interesting paper by Mr. Georges reprinted in the "Elek. Zeit.," Nov. 22; he discusses the starting of shunt and three-phase motors, more particularly the latter. He discusses theoretically the proportioning of the step-by-step resistances. He gives a summary of the numerous devices which have been used and proposed for starting three-phase motors to obviate the employment of sliding contacts on the armature; up to a certain size he shows that the motors may be built without any particular device for starting them, assuming that the source is sufficiently large; to insert the starting resistance in the primary circuit reduces the voltage and the result is similar to inserting it in series with a whole shunt motor, including its magnet windings; it should be remembered that an increased torque requires a greater current than when the resistance is put in circuit with the armature; this method has been applied by the General Electric Company, of Berlin, using choking coils in place of resistances; the same thing can also be accomplished in the motor itself by dividing the stationary windings into two halves, connecting them in series at starting, and in parallel when running normally, or in the case of three-phase motors by connecting the three-phase windings by the star system at starting, and by the triangular system while running normally; this has been used by the firm of Siemens & Halske. Another method consists in leading the current of the armature through contact rings into the armature of a second motor, which will then run with a speed equal to the loss of the speed of the first motor, the sum of the speeds of the two motors being practically constant, and the power lost in the first motor will become available in the second; if they are connected on the same shaft the speed will be reduced to one-half; the winding, containing the induced current in the second motor is stationary, and the starting resistance is connected into that circuit; such a motor built by Siemens & Halske is in use in a mine; the objection to it is the increased cost. The Oerlikon Company has proposed a system in which there are two windings on the armature, an auxiliary one of high resistance and few windings, and the main one of low resistances and many windings, respectively; it involves difficulties on account of the heating, and to overcome these the arrangement shown in Fig. 1, is used by the firm of Siemens & Halske; in this there are two coils in each



FIGS. 1 AND 2.—STARTING THREE-PHASED MOTORS.

branch which are connected so that their E. M. F.'s oppose each other when the motor is started, during which time the outside terminals C_1, C_2, C_3 are not connected with each other; the ampere-windings are also connected so as to oppose each other, the result being that only one-ninth of the ampere-windings are active; for the same torque the loss of speed will therefore be nine times as great as it would be if all the E. M. F.'s act in the same direction; he shows that the heating due to the current will also be reduced to one-ninth; when running normally the three terminals are connected together by a short circuit; a motor thus constructed gave good results; he shows how this may be applied to a step-by-step arrangement for starting. Another method is shown in Fig. 2; the armature contains two equal windings placed at a slight angle

with one another; their E. M. F.'s will be equal, but will differ in phase; if their ends are connected, as shown by single lines, the E. M. F.'s in those connections will be proportional to the lengths of those lines—that is, they will be small; if they are connected as shown by the double lines, the E. M. F.'s will be proportionately greater; if they are all connected together, it will form two independent three-phase windings in which the full E. M. F.'s will exist. In conclusion he states that he does not wish to recommend any one of the above systems as the best, but from a physical standpoint a true resistance in the armature circuit is the best means for starting; in that case one can obtain the full torque without increasing the current above that for full load; or by increasing the current the torque can be increased proportionately: but contact rings are then necessary, and to avoid these, it would be preferable in many cases to choose one of the other methods.

Rotatory Field Motors.—Some notes compiled by Prof. S. P. Thompson for the use of his students, explaining in a very clear and simple manner the theory and action of these motors, are published in the Lond. "Elec.," Nov. 23; he discusses the elementary theory, the resultant magnetic flux, the conditions of operation, the starting torque, and the relation between torque and slip; it does not admit of being abstracted; the compiler recommends the article to students and beginners.

E. M. F. and Current Curves of Alternators.—An editorial in the Lond. "Elec. Rev.," Nov. 23, abstracts a paper by Mr. Frith describing some experiments to find out how far the behavior of the machine follows the theory and how many of the Fourier's expressions should be taken into account. The machine was a Wilde alternator, having iron in the armature; the E. M. F. was measured with the usual intermittent contact apparatus, and the magnetization curve of the iron was determined by a flat coil, which could be suddenly withdrawn from between the coils and the armature. The curves show that the self-induction of the armature decreased with the increase of the magnetization of the iron in the cores. The regularities in the curve died out when power was taken from the machine, and it becomes nearly straight at first and then approaches the sine curve; the surging of the lines of force of the field magnets was also examined; the motion of the magnetic field accounted in a large degree for the deviation from simple sine curves; when the armature contains iron he concludes that at least three terms of the Fourier's expression must be considered; especially the third, the second being generally comparatively small; the machine had a large armature reaction, and the deformations were somewhat exaggerated by the primitive design of the machine.

Motors and Dynamos.—In a continuation of the description of the electrical exhibits at the Lyons Exhibition, Mr. Jacquin in "L'Eclairage Elec.," Nov. 3, describes with illustrations some of the machines, including a bi-phase synchronous and a non-synchronous motor.

TRANSFORMERS.

Principles of Transformer Design.—The article by Mr. Still is concluded in the Lond. "Elec.," Nov. 23, and treats of the design and manufacture of transformers; the copper and iron losses are discussed and formulas are given; the eddy current losses in the iron should be very small; they vary as the squares of the induction and frequency and thickness of the plates; the following formula gives the watts by eddy-currents lost per pound of well-insulated iron plates,

$$\frac{1.4}{10^{10}}\, t^2\, n^2\, \mathfrak{B}^2$$

in which t is the thickness of the plates, n the frequency and $\mathfrak{B}$ the maximum induction in lines per square inch. For the hysteresis losses in watts per pound for a good quality of iron he gives the following formula:

$$0.88\, n\, \mathfrak{B}^{1.55}\, 10^{-9};$$

to obtain the watts loss per cubic inch, multiply 0.28; for 16,000 lines per square inch and a frequency of 100, the hysteresis losses vary between one-quarter of a watt and half a watt or even more, per pound. A table is given showing the losses per pound, with a frequency of 80. Regarding the thickness of the plates he states that there is no advantage in making it less than 0.013 or 0.012 inch; (in his calculations he generally uses 0.014). Regarding the insulation between the plates, he states that for paper insulation the ratio between the space occupied by the iron and the total space is about 0.85, and with a thin coat of varnish instead, it may be as much as 0.9. The most economical load for a transformer is that which makes the copper losses equal to the iron losses; to prevent excessive heating, a cooling surface of about 4 sq. in. per watt lost in the transformer should be allowed; it is a mistake to reduce the losses beyond certain limits unless it can be done by using better iron; in a good transformer for lighting purposes with a maximum "drop" of 2 per cent., the losses should be about 70 watts in the iron and 60 in the copper for a 3 kilowatt transformer, and 100 watts in the iron and 110 in the copper for a 6 kilowatt transformer; he claims that there is no great advantage in reducing the reluctance of the air-gap very much, and that an appreciable air-gap does not necessarily imply a loss of efficiency. He discusses at some length the calculation of a transformer from another of the same type, but of different capacity. In the summary of the formulas he gives the following for the magnetizing current in good closed magnetic circuit transformers,

$$\text{Magnetizing current} = \frac{\text{total watts lost in iron}}{\text{primary E. M. F.}} \times 1.4$$

in which the factor 1.4 is the reciprocal of the power factor.

ARC AND INCANDESCENT LIGHTS.

Researches with the Electric Arc.—The conclusion of the paper by Dr. Sahulka, the first part of which was abstracted in the Digest, Dec. 1, is published in the "Zeit. fuer. Elek.," Nov. 15. He describes measurements made to determine the voltage between the electrodes and the arc (referring apparently to an alternating current arc between iron and carbon); a small carbon rod was introduced into the arc as a terminal; the arc was found to be positive as compared with both of the electrodes; in one case the voltage of the whole arc was 28.3, that between the arc and the carbon was 4.6, and that between the arc and the iron was 32.8 volts; that of the whole arc was, as a rule, equal to the difference (the algebraic sum) between the other two, referring to those between the arc and each of the electrodes; the measurements were always made after the small carbon point, used as a terminal, was at a white heat. He describes some very curious results, some of which cannot be explained; for instance, different results were obtained when a torsion galvanometer was used than when a simple galvanometer was used; the results were also different when the voltages were measured separately, than when measured together, and in some cases the voltage changed signs when measured with one instead of two instruments. A curious result was obtained when it was attempted to compensate the continuous current generated in the arc; it was done by means of accumulators, but it was not possible to neutralize the continuous currents, as the arc then became small and was extinguished; the continuous voltage became smaller the more nearly this continuous current was compensated. It was also shown, by means of a telephone in series with a condenser and connected to the two electrodes, that the arc consists of disruptive charges; when no arc existed, a certain note was heard corresponding to the frequency, but when the arc was formed the note became louder and higher in pitch, caused, it is thought, by disruptive discharges; if the arc was formed with a continuous current a loud hissing noise was heard. He then describes some researches with the alternating current arc between carbon electrodes; when the arc was vertical the upper carbon was always negative as compared with the lower and showed a continuous voltage of about 2.8 volts; when the arc was horizontal no such continuous voltage existed and there was no continuous current in the circuit; when the arc was horizontal a continuous voltage existed between the arc and the electrodes, the arc being negative to both of them, the voltage being about 7; if a shunt circuit was made between the arc and one of the electrodes a continuous current flowed through it. In conclusion he makes some deductions and states that these experiments show that there is a true counter E. M. F., generated in the alternating current arc, and it may, therefore, be inferred that it exists also in the continuous current arc. In the discussion which followed, Prof. Lecher remarked that he had noticed that the needle of a tangent galvanometer was deflected by an alternating current and that it is only with a specially constructed galvanometer that the existance of a continuous current can be proved.

ELECTRIC RAILWAYS.

Steep-Grade Traction.—An Institution paper by Mr. Preller on electrical steep grade crossings in Europe is reprinted in the Lond. "Elec. Eng.," Nov. 23. He gives a synopsis of what has been done in this direction in Europe, more particularly in Switzerland, compares results and draws conclusions; he shows the advantages of cable traction on mountain roads when the cable is operated by electrical motors; he finds that the cost of construction is about 40 per cent less and the working expenses are only about one-half as great. Regarding the cost of operating adhesion or rack railways by steam and by electricity, he concludes that irrespective of the immensely greater elasticity of the service and consequently the far more rapid development of the traffic, electrical working ensures an economy of at least 50 per cent. compared with steam. Among his general conclusions he states that vertical high-speed engines suitable for direct driving generally work uneconomically on account of the rapid variations of the load; the first cost of a hydro-electric installation often exceeds that of a steam plant, especially with low-pressure turbines; high pressure turbines are always preferable and more economical; where cheap hydraulic power is not available within a distance of about four miles, gas manufactured on the spot is much more economical than steam. Regarding the trolley, he believes that if the lines contain many and short curves, the sliding contact wire as used by Siemens & Halske is far preferable; regarding the subject of continuous and alternating currents for traction, he believes that the latter is destined to supplant the former and that it will insure a saving of about 30 per cent. in the weight of dynamos and motors, irrespective of the saving in copper, and will thus considerably simplify and cheapen electrical installations.

Street Railways.—The "Zeit. fuer Elek.," Nov. 15, abstracts a recent paper of Mr. van Vloten which contains some interesting statistics regarding the electrical lines in Europe at the end of 1893; the total mileage of roads in operation was 186, of which a third was in Germany; there were about 105 miles under construction; 27 out of 44 are operated by the trolley system.

Light Railways.—The discussion of the subject of light railways in England is continued in the Lond. "Elec.," Nov. 23.

Rail Bond.—A bond devised by Mr. Robinson is illustrated in the Lond "Elec. Eng." and "Elec. Rev.," Nov. 23. The terminals consist of short wrought iron tubes expanded into the webs of the rails in the

same way in which boiler tubes are secured; the ends of the copper wire are then wound around these projecting tubes.

Submarine Boats.—The English journals of Nov. 23 give a few further facts about a recent trial of the boat "Gustave Zede." It is 113 ft. long and displaces about 226 tons; the speed attained was from five to eight knots per hour with 300 accumulators on board; although the boat was not submerged for a single moment, the acid vapors from the batteries caused great discomfort to those on board; unless the latter feature can be remedied it will be impossible to submerge it for more than a few moments at a time.

Leads for Railway Circuits—See an abstract under "Wires, Wiring and Conduits."

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Alternating Current Motor System.—An article by Mr. Imhoff is published in the "Elec. Zeit," Nov. 22; he claims to have invented the system in the summer of 1893 and states that it admits of regulation and of the combined use for light and power. It consists in supplying a second current from the station, which is to be used only for starting the motors; a small secondary dynamo is coupled directly to the main machine and generates a current differing by 90° from the main current; this requires the use of one or two extra leads which, however, are run only to installations containing motors, and as they are used only for starting the motors, the leads may be quite small; this will enable motors to start like three-phase motors with a large starting torque; when the system contains secondary stations then the auxiliary current may be generated there instead of at the main station.

Theory and Practice in Electrical Engineering—In an article by Mr. Kennedy in the Lond. "Elec. Rev.," Nov. 23, he described the agreement and disagreement between theory and practice. Among other things he states that there is not much superiority in the three-wire system over the older multiple series system; in comparing the alternating and continuous current systems he shows the absurdity of using the former for short distance transmission and cites several cities in which the alternating current system was used although distances were not great; to abandon parallel running is a mistake both in theory and in practice unless there is storage to fall back upon; if alternators are run separately duplicate machines must be provided and kept going ready to switch on at any moment; the disadvantages of alternating currents have been multiplied ten-fold by what he calls the insane practice of adopting various frequencies.

Lighting Installations.—The discussion of Mr. Henderson's paper mentioned in the Digest last week, is published in the Lond. "Elec. Rev.," Nov. 23.

WIRES, WIRING AND CONDUITS.

Inductance in Aerial Lines.—The serial by Prof. Blondel (see Digest, Dec. 1) is continued in "L' Eclairage Elec.," Nov. 10. He compares the different systems in regard to the inductance on the lines and gives an interesting table showing the relative weight of copper, the ohmic resistances, the loss of energy and the diameter for all the different systems under different assumptions; he makes comparisons, gives a number of simple formulas, and applies them in making deductions from the famous Lauffen-Frankfort transmission plant; he also discusses the different dispositions of the four wires on the lines, to furnish the inductance. Among other things he states that the figure given by Mr. Scott in a recent paper on polyphase transmission is below the correct value—referring to the statement that the inductions of a triphase line is reduced to 0.54 per cent. of that of a monophase line. (As the discussion of this subject involves many complications it might be doing injustice to the author to abstract particular results without giving all the necessary qualifications; the discussion appears to be a very complete one and may be recommended to those specially interested in this subject).

Leads for Railway Circuits.—A paper by Mr. Dierman is abstracted at some length in "L'Eclairage Elec," Nov. 10. He describes in detail a method for calculating the leads and feeders, which is partially graphical and which he believes has not yet been used. Having given the profile of the road, the position of the cars, the speed and similar data, he constructs a diagram giving the force of traction as ordinates on a base line corresponding to the base line of the profile from a diagram giving the efficiency of the motor at various speeds; he then converts these ordinates into those representing the current required at every point along the route; from these he then calculates the leads and feeders, calling attention to the fact the loss in the line is proportional to the square of the current and that therefore it is not correct to base any calculations on the mean current strength; but it should be based on the square root of the mean of the squares; he also states that the general method based on a maximum loss requires much more copper than is really necessary. An example is worked out.

Wiring Regulations.—Those adopted in Manchester are published in the Lond. "Elec. Eng.," Nov. 23.

TELEGRAHY, TELEPHONY AND SIGNALS.

Switchboards for Telephone Stations.—A new arrangement by Mr. Engelmann is described and illustrated in the "Elect. Zeit.," Nov. 22. It appears to be a simplification and can be adapted to an almost unlimited number of subscribers besides being quite a little cheaper; it appears to differ but little from that used in Buffalo, N. Y.

Telephone Building.—A description of the new building of the National Telephone Co. is given in the Lond. "Elec. Rev.," Nov. 23.

Sub-Marine Telegraph.—An article by Mr. Marcillac is begun in "L'Eclairage Elec.," Nov. 10. He gives a review of the subject beginning with the original Morse system.

ELECTRO-CHEMISTRY.

Extracting Gold.—The Lond. "Elec. Rev.," Nov. 16, contains an article by Mr. Andreoli on cyanide and electrolytic cyanide solutions, which is of special interest in connection with a recent lawsuit; he shows that the use of cyanide solutions has been known for a long time and replies to a number of statements to the contrary. "L'Eclairage Elec.," Nov. 3, contains the first part of an article of a similar nature by the same author, in which he discusses also the application of electricity in the process; both articles contain a large number of interesting references to previous publications.

Electro-Deposition of Gold.—Mr. Weightman, in the Lond. "Elec. Rev.," Nov. 23, discusses some of the points brought up by Mr. Andreoli (see Digest, Dec. 1 and 8). He calls attention to the fact that as the solution gets weaker it becomes more difficult to remove the last traces of the gold and he suggests allowing the last traces to remain there and using the solution over again, thus always leaving a small quantity of gold as an essential part of the working solution; he shows the importance of circulation, especially with weak solutions. He believes the questions of anodes is not as important as is supposed; many substances will answer, especially iron, which will not form Prussian blue unless allowed to oxidize; he suggests that the disintegration of carbon is very slow; the cathode surface should be as great as possible while the size of the anode makes no difference except in the voltage; the chief objection to using a great current is the large amount of the cyanide which it would decompose; he quotes Mr. Gernet as saying that a better result is obtained by doubling the plates than by increasing the current tenfold.

Local Action in Accumulators.—The subject is discussed in a general way by Mr. Darrieus in Lond. "Elec.," Nov. 17. Among other data he gives the following figures: Perioxide of lead and a grid of antimony lead give an E. M. F. of 1.40 volts; he shows by the following experiments that the active material is perioxide of lead, contrary to what is supposed; a small capsule of platinum was filled first with perioxide prepared by a chemical process and then with electrolytic peroxide in each case measuring the E. M. F. with the same negative plate and obtained 2.05 volts in each case; a grid of antimony lead and a plate of spongy lead, both emerged in sulphuric acid gave 0.52 volt.

Pocket Accumulator.—The results of some tests of a dry Fitz-Gerald accumulator are given in the Lond. "Elec. Rev.," No. 23; it states that they indicate the possibility of great improvement in the construction of accumulators for traction and other purposes (the data given is so scant and incomplete that it is of little use); neither the voltage nor the capacity is given; the figures given make it impossible to compare it with others; the results are claimed to be remarkable and unprecedented.

Gas Battery.—A translation of the paper asbtracted in the Digest last week is published with the curves in the Lond. "Elec.," Nov. 23.

Electricity Direct from Coal.—An abstract of the paper of Dr. Borchers, mentioned in the Digest last week, is published in the Lond. "Elec. Rev.," Nov. 23, including the illustrations. A reprint of the whole article with illustrations is also published in the "Elek. Zeit.," Nov. 22.

Chemical Analysis.—The Vortmann process for estimating the halogens by means of electrolysis is briefly described in the Lond. "Elec. Rev.," Nov. 23.

Polarization.—An article from the "Weid. Ann.," Vol. 52, p. 191, by M. des Coudres is abstracted in "L'Eclairage Elec.," Nov. 10.

MISCELLANEOUS.

Electrical Plow.— A complete system for operating an electrical plow is described and illustrated in the "Elek. Echo," Nov. 17, including estimates of the cost of operation, which appear to show that it is about half the cost of operating a steam plow; the source of power is a transportable boiler and engine, such as is used for agricultural purposes, and the plow is drawn by the winding up of a chain cable anchored at each end; the plow contains four shoes pointing in one direction and four pointing in the other, so arranged that the plow is drawn first in one direction and then in the other without requiring to be turned; the plant appears to have been in actual operation and is not a mere suggestion.

Electrically Operated Valves for Steam and Water Pipes.—A system is described and illustrated by Mr. Berg in the "Elec. Zeit.," Nov. 22.

Substitute for Guttapercha.—According to the "Elec Tec.," Nov. 15, Mr. Hutchinson has discovered a method for combining India rubber with guttapercha, the combination forming a much cheaper compound; it consists of 50 parts of guttapercha, 30 parts of India rubber and 20 parts of "Lanichol," which is a substance obtained as a by-product in

the preparation of wool and is obtained from the oil in the wool, and known by the name of "cholecaterin;" the mixture is heated to the boiling point of water, it has all the properties of guttâpercha and in addition it is better as it does not oxidize.

Carborundum.—The Lond. "Elec. Rev.," Nov. 23, states that a company in Frankfort, Germany, have recently produced a new product which they call carbonit-caiborundum, and which is said to excel carborundum in durability without any loss of sharpness; it can be used in larger grains and is cheaper.

Electrolysis in Urethral Stricture.—An article by Dr. Newman, of New York, describing the treatment, which appears to have been a very successful one, is published in the Lond. 'Elec. Rev.," Nov. 23.

New Books.

Electric Lamps and Electric Lighting. A Course of Four Lectures on Electrical Illumination Delivered at the Royal Institution of Great Britain. By J. A. Fleming, M. A., D. Sc., F. R. S. New York: The D. Van Nostrand Co.; London: *The Electrician* Printing and Publishing Company, Ltd. 228 pages, 93 illustrations. Price, $3.00.

This handsomely printed and bound volume contains four lectures on "Electric Illumination," delivered by Dr. Fleming at the Royal Institution, London. The author in the preface states that the aim was originally only to offer to a general audience such non-technical explanations of the physical effects and problems concerned in the modern applications of electricity for illuminating purposes as might serve to further an intelligent interest in the subject and perhaps pave the way for a more serious study of it, stress being laid upon principles rather than upon details.

The first lecture deals with the elementary principles of electricity, light and photometry, the two latter being very satisfactorily considered and in terms easily understood by the non-technical reader. The second lecture takes up the incandescent lamp, and in the 75 pages included is given a great amount of information in regard to the principles upon which the lamp is constructed, its various forms, the relations, illustiated by curves, between the voltage, efficiency, life and candle power, the ageing of lamps, their luminous efficiency, etc. The lecture concludes with a consideration of the manner in which incandescent lamps can be employed in order to produce the best illuminating effect, and with a very full discussion of the "Edison effect."

The third lecture is devoted to arc lamps and the physical properties of the arc, including the distribution of potential and its temperature. The principles of arc lamp mechanism are explained and many points in practical arc lighting considered. This and the preceding division of the book form by far the best non-technical treatise we know of on the incandescent and arc lamp and the accuracy and extent of the information are such as to make it welcome to the technical reader.

Electrical distribution is the title of the concluding lecture, though the greater part is devoted to explanations of the dynamo and transformer, including an exposition of the principles of the dynamic generation of electricity. Several types of machines are illustrated and a number of illustrations, including that of Tivoli near Rome, are well described.

As a work for non-technical readers who wish to attain correct ideas in regard to electric lamps and electric lighting this is perhaps the best book now in print. It will also be found useful by the student and electrician and even the educated engineer will find gathered in it a considerable amount of information that otherwise he would have to seek for in scattered periodical literature.

Electric Lighting Plants. Their Cost and Operation. By W. J. Buckley. Chicago: William Johnston Printing Company. 279 pages, 32 illustrations, 19 plates. Price, $2.

The preface states that the writer of this useful little book is "neither electrician, engineer nor expert, but a salesman"—identified with one of the large electrical manufacturing companies since 1884. While we find in the pages occasional evidence of the correctness of this statement, yet the work is one that contains a great deal of useful technical information, and the remarks of the writer directing prospective purchasers' attention to the points to be observed in considering the details of an installation are well worthy of respectful attention. The author frankly avows that, having been identified for years with a particular electrical manufacturing company, he has "in a noble effort to deserve his salary," mentioned no other lighting apparatus but that made by his company; nevertheless, having been thus warned, the reader will doubtless be surprised at the modest advantage taken in this respect.

The book contains a large number of tables of the cost of the various parts that go to make up a complete lighting equipment, including several estimates for complete plants. In addition there are numerous other tables of data, the character of the work, in fact, being to a great extent similar to that of pocket manuals. The "Instructions for Employees" of Mr. J. I. Ayer are included, as well as the insurance rules of the Underwriters International Electric Association, and the similar compilation of the National Electric Light Association.

While the book is largely a compilation, and the matter is rather poorly arranged, it will nevertheless prove a useful work to the many who care for practical information uncomplicated with references to theory and authorities.

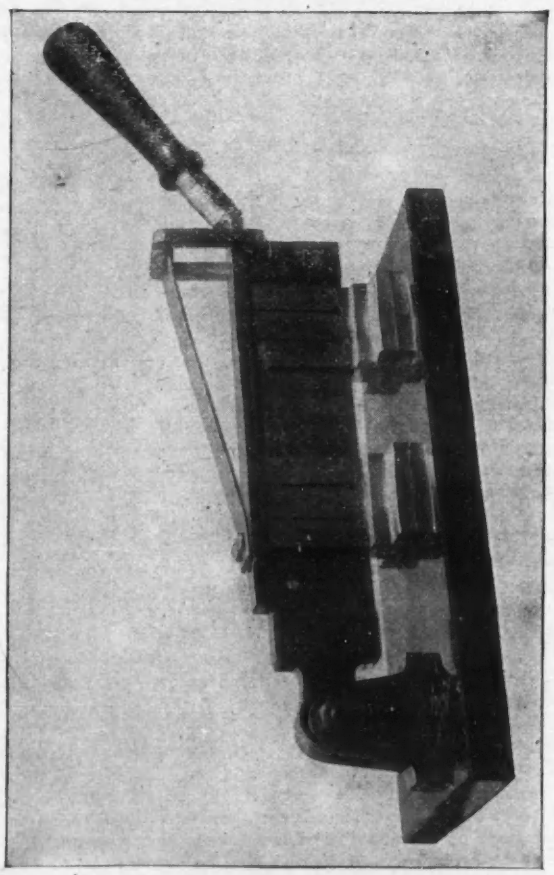
Electric Railway Motors. Their Construction, Operation and Maintenance. By Nelson W. Perry, E. M. New York: The Street Railway Gazette Company. 238 pages, 60 illustrations Price, $1.00.

This little book admirably fulfills its object, which, as stated in the preface, is to provide for motormen an intelligent elementary exposition of the principles upon which are founded the apparatus they are called upon to handle, and give instruction in regard to the care of street railway motors and the detection, remedy and prevention of their faults. The electrical principles upon which the theory of the motor and its operation is based are logically and intelligently developed from the simplest conceptions and, with reference to home-made experimental apparatus, cheaply and easily made. Somewhat more than half of the book is devoted to the explanation and development of theory and the remainder to descriptions of various systems and practical instructions, though the former are rather meagre. The final chapters are of particular value as they contain a compilation from many sources, with additions by the author, of specific directions for the management of motors, the remedy of faults, directions to motor men, instructions for inspectors and superintendents, etc.

The work is a vast improvement on the style of books usually written for practical men, not only in being scientifically correct, but from the conscientious endeavor apparent throughout to render intelligible to the reader every phase of the subject, notwithstanding the inherent difficulty, coming within the scope of the book. As a rule, books written for this class of readers, particularly if written by one of them, are weak in both of these particulars and frequently offensive through a patronizing air entirely absent in the present instance. On the other hand, a noticeable defect is a diffuseness which at times is excessive, as, for example, where almost six pages are required to relate a little anecdote and point the moral.

High Tension Switch.

The accompanying cut illustrates a switch for high tension currents and railway work, recently brought out by J. Grant High & Company, 123 N. Third street, Philadelphia. In getting out this switch the inventor, Mr. George T. Eyanson, treasurer for the above firm, had in mind the principle that in a quick break switch the contact between the blade and clips should remain intact until by lifting the handle all the resiliancy in the spring is stored up; the handle-piece then coming in contact with



High Tension Switch.

the head of the yoke gives a dead lift, releasing the hold of the clips on the blade, causing it to spring out and thereby giving a quick and long break. The handle-piece in the switch shown is made of steel, hinged in the back of the blade and extends through and snugly travels in the yoke, thus giving additional strength to the blade and insuring it from damages. This application of the spring can be used either on single, double or triple pole switches.

Copper Fuses.

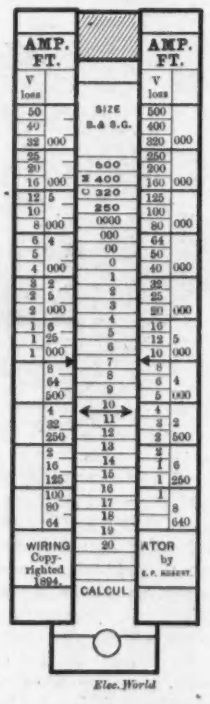
We print herewith a table giving diameters of copper fuses for currents to 1,000 amperes, compiled by Mr. Eustace Oxley and sold, well-printed on a large sheet, by H. E. Robinson, 61 West 133d street, New York. The table is computed from the law that the fusing point varies as the square-root of the cube of the diameter, using a constant determined by Preece in his classical experiments.

Current in Amperes	Diameter in Inches	Current in Amperes	Diameter in Inches	Current in Amperes	Diameter in Inches	Current in Amperes	Diameter in Inches	Current in Amperes	Diameter in Inches	Current in Amperes	Diameter in Inches
1	.0021	51	.0293	101	.0480	155	.0612	405	.1161	810	.1843
2	.0034	52	.0295	102	.0462	160	.0625	410	.1170	820	.1858
3	.0044	53	.0300	103	.0466	165	.0638	415	.1180	830	.1873
4	.0053	54	.0303	104	.0469	170	.0651	420	.1190	840	.1888
5	.0061	55	.0307	105	.0472	175	.0663	425	.1199	850	.1903
6	.0070	56	.0310	106	.0475	180	.0676	430	.1208	860	.1917
7	.0077	57	.0314	107	.0478	185	.0688	435	.1217	870	.1932
8	.0085	58	.0316	108	.0481	190	.0701	440	.1227	880	.1947
9	.0092	59	.0321	109	.0484	195	.0713	445	.1236	890	.1962
10	.0098	60	.0325	110	.0487	200	.0726	450	.1246	900	.1976
11	.0105	61	.0330	111	.0490	205	.0737	455	.1254	910	.1991
12	.0111	62	.0332	112	.0493	210	.0749	460	.1264	920	.2005
13	.0117	63	.0336	113	.0496	215	.0761	465	.1273	930	.2020
14	.0123	64	.0339	114	.0498	220	.0773	470	.1281	940	.2034
15	.0129	65	.0343	115	.0501	225	.0784	475	.1291	950	.2049
16	.0135	66	.0346	116	.0504	230	.0796	480	.1300	960	.2064
17	.0140	67	.0350	117	.0507	235	.0807	485	.1309	970	.2078
18	.0146	68	.0353	118	.0510	240	.0819	490	.1318	980	.2093
19	.0151	69	.0357	119	.0513	245	.0830	495	.1328	990	.2106
20	.0156	70	.0360	120	.0516	250	.0841	500	.1336	1000	.2120
21	.0161	71	.0364	121	.0519	255	.0853	510	.1354		
22	.0166	72	.0367	122	.0522	260	.0864	520	.1371		
23	.0171	73	.0370	123	.0524	265	.0875	530	.1389		
24	.0176	74	.0374	124	.0527	270	.0886	540	.1406		
25	.0181	75	.0377	125	.0530	275	.0897	550	.1423		
26	.0186	76	.0380	126	.0533	280	.0908	560	.1441		
27	.0191	77	.0384	127	.0536	285	.0918	570	.1457		
28	.0196	78	.0387	128	.0539	290	.0929	580	.1474		
29	.0200	79	.0390	129	.0541	295	.0940	590	.1491		
30	.0205	80	.0394	130	.0544	300	.0950	600	.1509		
31	.0209	81	.0397	131	.0547	305	.0961	610	.1525		
32	.0214	82	.0400	132	.0550	310	.0971	620	.1543		
33	.0218	83	.0403	133	.0553	315	.0982	630	.1566		
34	.0222	84	.0407	134	.0555	320	.0992	640	.1575		
35	.0227	85	.0410	135	.0558	325	.1003	650	.1592		
36	.0231	86	.0413	136	.0561	330	.1013	660	.1607		
37	.0235	87	.0416	137	.0563	335	.1023	670	.1624		
38	.0240	88	.0419	138	.0566	340	.1033	680	.1640		
39	.0244	89	.0422	139	.0569	345	.1043	690	.1656		
40	.0248	90	.0426	140	.0572	350	.1053	700	.1671		
41	.0253	91	.0429	141	.0574	355	.1063	710	.1688		
42	.0256	92	.0432	142	.0577	360	.1073	720	.1703		
43	.0260	93	.0435	143	.0580	365	.1083	730	.1719		
44	.0264	94	.0438	144	.0583	370	.1093	740	.1735		
45	.0268	95	.0441	145	.0585	375	.1103	750	.1750		
46	.0272	96	.0444	146	.0588	380	.1113	760	.1766		
47	.0276	97	.0448	147	.0591	385	.1122	770	.1781		
48	.0280	98	.0451	148	.0593	390	.1132	780	.1797		
49	.0284	99	.0454	149	.0596	395	.1141	790	.1812		
50	.0288	100	.0457	150	.0598	400	.1151	800	.1827		

DIAMETERS OF COPPER FUSES.

Slide Rule Wire Calculator.

The slide rule wire calculating scale we illustrate, the invention of Prof. E. P. Roberts, of the Correspondence School of Technology, Cleveland, O., is based on the following principles: 1st. No. 10 copper wire measures 1 ohm per 1,000 feet, and is 0.1 inch in diameter, and, therefore, is of 10,000 circular mils cross section. 2d. Each third size larger doubles in area, halving the resistance. 3d. Each size is 0.8 the resistance of the next larger or 1.25 of the next smaller.



SLIDE RULE WIRE CALCULATOR.

From (1) it follows that 1,000 ampere-feet of No. 10 wire must have one volt drop with one ampere. This is noted in the left hand column of the scale. When the arrows are in line it will be seen that No. 10 wire has 1,000 in the line on the left. This 1,000 represents ampere-feet. The first figure is separated from the others by a vertical line. The portion to the left of the line represents volts; thus 1,000 ampere feet has one volt loss for No. 10 wire. In the right hand column the figures are ten times those on the left; they likewise represent both ampere-feet and volts loss, and, when the arrows are in line, they also represent circular mils.

From the above it will be seen that the scale is founded on a law which, when fully comprehended, makes its use very simple and reliable. To find the size wire for any given number of volts loss and ampere-feet, all that is necessary is to place the arrows on the slide opposite the volts loss, and note the size wire in line with the ampere-feet. To find the drop for any given size, reverse the above.

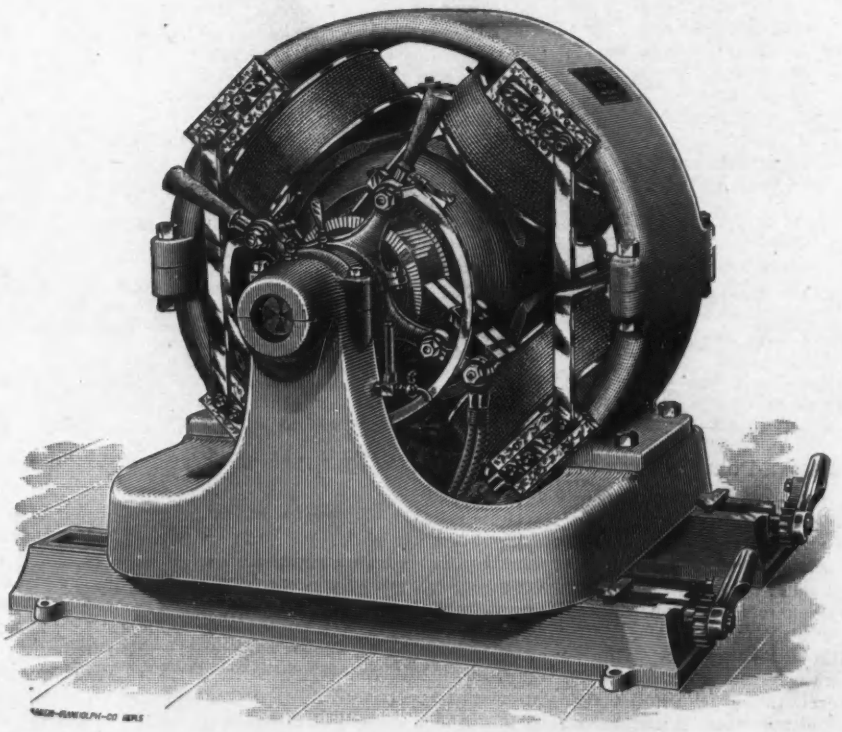
As areas are obtainable it is possible to compare wire of different sizes and obtain the equivalent value of a cable, etc. On the back of the scale is printed the carrying capacity according to the insurance rules, and also examples of use. The scale is enclosed in a leather case made to fit the vest pocket, and is accompanied by a leaflet of examples of use more elaborated than is possible on the back of the scale.

Multipolar Generators and Motors.

A new line of slow speed, multipolar generators and motors has recently been placed on the market by the Commercial Electric Company of Indianapolis, which, as will be seen from the cut, are exceedingly compact and neat in appearance. Their slow speed, the small floor space required and their high efficiency, make them especially desirable machines for both lighting and power.

The armatures, which are of the smooth core, Gramme ring type, are made of a special grade of iron having a minimum hysteretic loss, and the absence of teeth entirely does away with eddy currents in the pole pieces and the sparking due to high self induction. The armatures are thoroughly ventilated, and this, together with the large cross section of the conductors and the freedom from core loss obtained by the above construction, results in a very low rise in temperature. Each coil of the armature is entirely independent, and if damaged can be renewed without disturbing any of the others. The commutator is made of the hardest copper and clear sheet mica insulation and the great useful depth of the segments permits of turning it down many times without necessitating renewal.

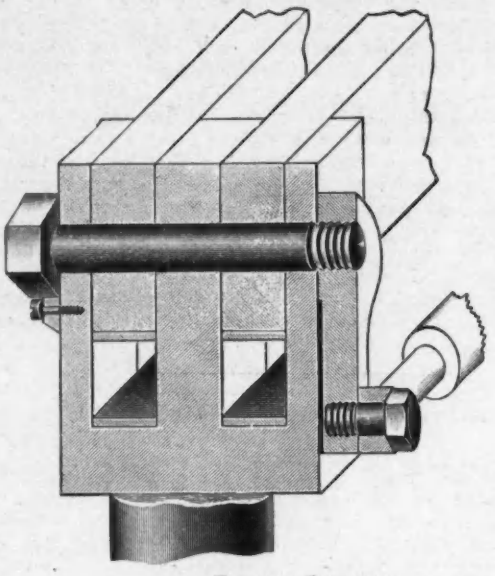
The magnet frame is of cast steel of the highest permeability and is mounted on a broad cast iron base, which carries the bearings. The bearings are of the spherical, self-aligning type, and are provided with oiling rings which dip into an oil reservoir of large capacity, so that frequent renewals of the oil are avoided. The bearings have phosphor bronze linings, with a large bearing surface. The pulleys are of large diameter and have ample belt surface, so that the full power of the



COMMERCIAL MULTIPOLAR MACHINE.

machine may be transmitted with but light pressure on the bearings due to belt pull.

The field coils have a large radiating surface, and thus run at a very low temperature. They are easily removed and the series coils are placed at one end of the spool, so that either the series or shunt coil can be repaired without disturbing the other. The brush holders are mounted upon a rocker arm and have independent adjustment of position and tension. The insulation is of the highest grade and will withstand a pressure of 5,000 volts between the windings and the frame.



Bolted Contact.

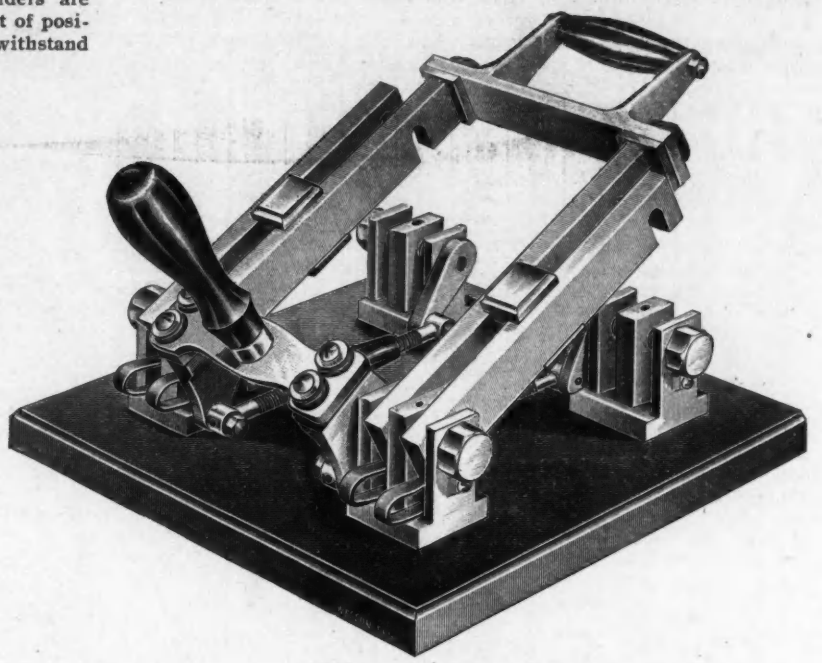
These machines are built in sizes from 40 to 100-kw., and are adapted for belt driving or direct connection. Their ability to withstand the sudden fluctuations of lead and the severe temporary over loads peculiar to street railway work make them especially valuable for that purpose.

New Switches.

We illustrate herewith several new forms of switches manufactured by Linton & Southwick, Worcester, Mass. One of these, shown above, is called a "bolted contact" switch, and is adapted for use in connection with currents running into the hundreds or thousands of amperes. There is a well recognized difficulty in the use of heavy current switches due to the necessity of having large contact surfaces and considerable pressure on those surfaces, thus causing excessive friction and requiring the exercise of considerable power to open and close them. In the switch illustrated, the contact bars or blades merely have a snug fit in the jaws connecting with the circuit, which, after making contact, are strongly pressed together by means of a crank-shaped disc or nut and a screw thread on a bolt passing transversely through the jaws and operated by a supplemental handle. When it is desired to open the switch, the supplemental handle is moved so as to release the tension on the jaws, and the switch is then easily opened. The sketch shows the details of construction in section.

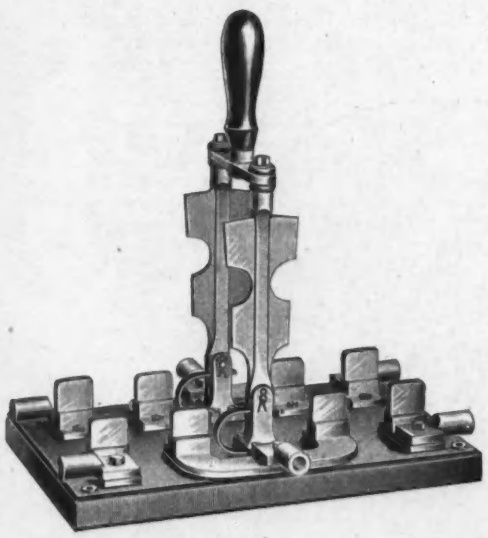
A quick-break switch is also shown, in which the contact blade is in two sections. In breaking contact the opening of the upper section places the lower one under the tension of a spring of special form, and when the friction of the contact surfaces is overcome this section flies up to the other, making an instantaneous break of considerable width, and preventing arcing.

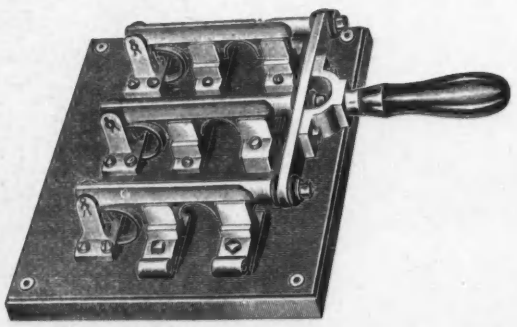
A form of spring employed for holding the blades of their switches



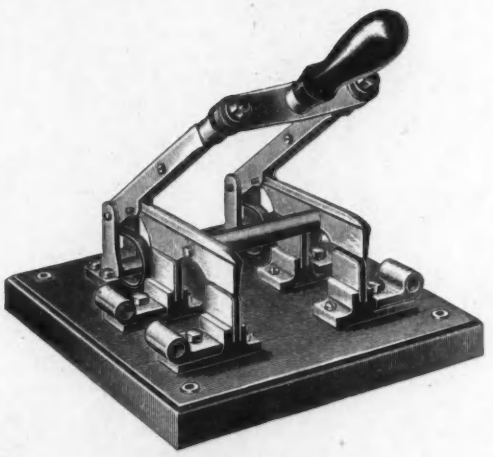
Bolted Contact Switch.

in position is employed, shown in two cuts below, which possesses several advantages in strength, simplicity and special temper.





Double-Pole Double-Throw and Three-Pole Single-Throw Switches, Showing Spring.



Quick-Break Switch.

Electric Lighting in Paris.

The Paris correspondent of the London *Electrician*, reports that the Municipal Council has had a proposal brought before it to withdraw from the Compagnie Parisienne de l'Air Comprimè (the Popp system) its right to lay cables under the public way. This is the illogical outcome of several gentlemen on the Board of the Société du Secteur de la Place Clichy having taken up analogous positions on the Board of the Popp concern. Although in possession of the finest district in Paris, the operations of the Compagnie Parisienne de l'Air Comprimè show a deficit of some 28 million francs. The financial supporters of this disastrous enterprise are determined at all costs to get out of this rut, and they have come to an agreement with the Sociètè de la Place Clichy to undertake the transformation of the Popp system into a five-wire network. This being so, the Municipal Council immediately thought that the Popp Company's area was going to be annexed by the Sociètè de Clichy, but if the statements of the two boards are to be credited, the two concerns will remain autonomous. For the first six months of 1894, the Compagnie Parisienne has improved its position, thanks not to increased receipts, but to reduced expenses. The profit and loss account shows a profit of 100,845 francs against a loss of 157,000 francs for the first six months of 1893; the working expenses exhibiting a reduction of 100,000 francs. The final net result, however, thanks to the financial burdens that weight the undertaking, is a loss of no less than 584,000 francs.

Electric Haulage.

The electric locomotive we illustrate has recently been brought out by The Jeffery Manufacturing Company, of Columbus, O., and is claimed to possess all the requirements that have been shown to be necessary during the long experience of this company in the designing and manufacture of mining apparatus. The locomotive is compact, strong, simple in arrangement and accessible, with very few parts that can get out of order, thus reducing the liability to delays and shut downs, which has been the great trouble with many locomotives designed in the past. One of the advantages obtained by the method of construction used is the interchangeability of parts on the locomotive, everything being in duplicate, or in other words, there are two locomotives combined in one.

This locomotive is built in three sizes, 40, 60, and 80-hp, the latter size being the one illustrated. The weight is 19,000 lbs.; length over all, 10 ft. 6 in.; width, 64 in. for a 42-in. gauge; height from rail, 32 in. It can run on a 30-lb. rail without excessive wear on the track, as 80 per cent. of the weight is supported on good flexible springs, making it impossible to hammer the track, as is the case where no springs are used or where connecting rods are used between the axles. The comparative small dimensions enable it to be used where any ordinary mine car can be used. It is short and has a small wheel base, enabling it to go around sharp curves without excessive friction on the rail. As will be seen from the illustration, the height of the locomotive being only 32 in. the drivers can pass, without cramping, through places 42 in. high. This is one of the most important features, as in low seams a large amount of roof has to be taken down to admit mules for hauling, and where the roof is of sand rock this is very expensive; in fact, cases are known where a saving of $3 per yard has thus been made by using locomotives. It may be advanced that a rope system has just the same advantages; undoubtedly it has, but as against this equality with electric haulage, rope haulage has a great many disadvantages when compared with the electric system. The locomotive can pick up the trip from any part by simply throwing the switch leading to it and if necessary it can be used for switching and delivering any car irrespective of its place on the trip, to any branch. An extension of the haulage system can be made by simply carrying out the wire, without interfering with the rest of the system; there are no sheaves to take care of; no splicing of ropes; no constantly increasing dead load to carry.

The locomotive illustrated is rated at 3,000 lbs. draw bar pull at 8 miles per hour, but it has been tested on a dry rail and showed a draw bar pull of 5,000 lbs.; with sand, this can be raised to 6,500 lbs., giving a very powerful starting locomotive, enabling the operator to get his trip up to speed very quickly and without any jarring or throwing the coal off the cars, as is the case with steam or compressed air locomotives and more particularly with rope. On the level this locomotive has pulled, at a speed of 8 miles per hour, 65 cars, each car weighing 1,200 lbs. and containing 3,000 lbs. of coal, making in all a load of 136 tons. At this mine the coal is being hauled for 1¼ cents per ton per mile; before the haulage system was put in, counting in dead work necessary to admit mules, the cost was 7½ cents per ton per mile. This plant paid for itself the first 14 months.

MINE HAULAGE ELECTRIC LOCOMOTIVE.

An Interesting Mining Installation.

An interesting electric mining installation has been in operation for some time past near Croville, Butte County, California, at the Banner Mine of the Development Syndicate, of which Major Frank McLaughlin is general manager. The particular interest in this installation is due to the fact that all the power required for both the mining and the milling of the ore, is electric. The power station is about two miles distant from the mine and mill, and water is obtained from the Feather River, under 112 feet head, operating two Pelton water wheels, which, in turn, drive two 85-hp direct current, 500-volt General Electric generators.

The power supplied by the generators is utilized in driving motors operating separately a ten-stamp gold mill, a rock breaker, a 10″ by 20″ Rand air compressor, and two pumps on the 300 and 500 feet levels of the mine, of the Knowles vertical triplex, single-acting type, one with plungers of 6½″ diameter by 8″ stroke, and the other of the same type, with plunger of 5″ diameter by 6″ stroke. The hoisting works are also operated by an electric motor, and the mine and mill lighted from the power wires. Owing to lack of water for power the hoist has thus far only been operated intermittently; but a large bulkhead has been recently built, which will store sufficient water to allow of its operation at all times in connection with the other apparatus.

The following extract from a letter by Mr. Frank McLaughlin, general manager of Development Syndicate, indicates the success of the installation:

"I take great pleasure in stating that the electric power plant installed by your company at the Banner Mine, for operating the mill, rock-breaker, lighting system, air compressor, and the pumps on the 300 and 500 levels, works perfectly and to our entire satisfaction."

Financial Intelligence.

The Electrical Stock Market

New York, Dec. 8, 1894.

ELECTRIC STOCKS have made a very gratifying showing during the week ending to-day. The whole stock market has developed a gloomy tendency that ill accords with the bright prospects for rising quotations of a month or so ago, but electric stocks have evidenced a strength very pleasing to the holders thereof. That their quotations should hold is quite in keeping with the continued reports of increasing business that reach Wall street from the head offices of the various manufacturing and operating companies.

GENERAL ELECTRIC'S quotations have fluctuated very little, and that in a drooping stock market is more a sign of strength than it is significant of inactivity. The company's management insists that its operations are nowadays absolutely divorced from Wall street significance, and anything but a rise in General Electric's quotations fails to do it anything like justice. Business is as good as ever, if not even better than has been previously reported. The company is understood to be figuring on an especially important contract, namely, to equip the Manhattan Elevated Railroad of New York City with electric power. Mr. Russell Sage, an influential director of the Manhattan Company, admits that steam as a motive power is to be supplanted by electricity. Experts who have investigated the situation say that power can easily be applied to all the lines from one central station. Plans and specifications have already been drawn up and are in the hands of the General Electric people for an estimate. The contract calls for the equipment of some 257 motor cars, the erection of power plants, etc., and what with their experience in providing the equipment for the Metropolitan and West Side elevated railroad companies of Chicago, the General Electric people express themselves as fully satisfied with their ability to secure this important contract. The company just now, however, has plenty of work on hand to keep it busy. It is now working on the first lot of motors—500 of 25-horse power capacity—called for by the Yerkes Chicago Street Railway contract, secured several months ago. This valuable contract expressly stipulates that all the electrical apparatus used by the Yerkes system must be bought from the General Electric Company. With the big orders on hand the company is employing between 3,000 and 5,000 men, working full time at the Schenectady works, all the heavy machinery running day and night, while at the Lynn shops 2,000 men are at work, a good part of the plant being also operated at night. As to the financial side of the company's affairs, no action has as yet been taken regarding the correction of the impairment of capital, and, according to a statemept in the Wall Street Journal, nothing will be done until after the annual meeting. Pending this matter, no dividend will be paid on the preferred stock, although it is being more than earned. But while there is a shadow of a doubt as to the legality of any such payment, the directors will be deterred from ordering it.

WESTINGHOUSE ELECTRIC preferred stock, as announced in these columns last week, is to receive a dividend of 1¾ per cent., the directors having ordered this week that preferred stockholders of record December 22, receive this quarterly payment on January 2 next. The payment is to be made in cash. Common stockholders are again left aside in the distribution of profits. The hopes of common stockholders receiving a share of the profits in the spring, are, however, understood to be well founded. Certainly the company is well in a position to make the payment, but it is deemed more advisable to lay aside a cash reserve. But the new Brinton works will prove a big source of profit to the company when one takes into account the improved methods of economical manufacturing introduced therein. The removal is being hastened as rapidly as possible and is expected to be completed by the first of the year. The week's quotations for Westinghouse Electric preferred and common stock issues show little change, nothing much having been done in them on the exchanges.

AMERICAN BELL TELEPHONE stock quotations evidence few transactions if fluctuations are taken into account. The Governing Committee of the Boston Stock Exchange has refused to permit official dealings in rights of subscription at 190 to the 5,000 new shares of capital stock recently authorized, owing to the clause in the company's circular regarding terms of subscription to the effect that stockholders are made liable in case of a failure of an assignee to make full payment. Of a necessity this clause forbids promiscuous changing of ownership to the rights in question.

WESTERN UNION Telegraph also fails to show signs of weakness, there being no signs of investment liquidation and the floating supply of stock being so small as to discourage the bears to repeat their unsuccessful campaign of last summer.

ELECTRIC STORAGE BATTERY stock has been strong on the announcement that it has acquired the rights and patents of the Consolidated Electric Storage Company, the battery patents and rights of the Brush Electric Company of Cleveland, the battery patents and all interests in connection with batteries and the good will of that branch of the business of the General Electric Company, all the property rights and patents of the General Electric Launch Company and the Electric Launch and Navigation Company, and the rights, licenses and patents of the Accumulator Company. These purchasers would virtually place in control of the Electric Storage Company all of its former competitors in the business of supplying storage batteries and put an end to all litigation over patent rights. An official of the Consolidated Storage Company, the accumular concern of the General Electric Launch Company, says of the Storage Battery deal: "Negotiations are pending towards a consolidation of all storage battery companies, though nothing has come to a head as yet. Accumulator concerns have used up all possible profits for the last ten years in patent litigation, and by combining we will stop fighting each other, as well as producing a storage battery which will have the best qualities of the accumulators now in the market." Since the announcement of a probable storage battery company consolidation, the Consolidated company's stock has gone up several points.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES' trustees have purchased and cancelled 444 shares of preferred stock paying an average price of $105.72 per share, the highest yet paid. This makes 18,159 preferred shares cancelled to date.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Chicago Edison Company	100	127	130
Cleveland General Electric	100	80	90
East River Electric Light Co.	100	—	50
Edison Electric Ill., New York	100	98⅛	100
" " " Brooklyn	100	109	112
" " " Boston	100	127	128
" " " Philadelphia	100	120	125
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	39	40
Electric Construction & Supply Co., com.	15	7½	10
" " " pref.	15	7½	10
Fort Wayne Electric	100	2	3
General Electric	100	35½	36
General Electric, pref	100	70	72
Westinghouse Consolidated, com.	50	33	34
" " pref	50	50	51

BONDS.

Edison Electric Ill., New York	1,000	107⅞	108
Edison Electric Light of Europe	190	75	85
General Electric Co. deb. 5's	1,000	89½	90

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	198	200
American District Telegraph	100	35	40
American Telegraph & Cable	100	90	91
Central & South American Telegraph	100	102	105
Commercial Cables	100	130	145
Erie Telephone	100	52	53
Gold & Stock Telegraph	100	103	105
Mexican Telegraph	100	180	190
New England Telephone	100	67	69
New York & New Jersey Telephone	100	97	98
Postal Telegraph-Cable	100	50	55
Western Union Telegraph Ex-div.	100	88	88⅛

THE ELECTRIC TRACTION STOCK market has failed to develop any particular feature during the past week, but quotations for out of town securities hold extremely well. Rumors come to hand of new consolidations, whose issues will be traded in here, the latest being a revival of the old story that all the New Haven, Conn., street railroads are to be consolidated, nearly all being now in one company. In Philadelphia, also, talk is still heard, despite contradictions, of coming unions of important electric railroad interests, while New York traders persist in telling the story that the Metropolitan Traction Company is to ally itself with the Manhattan Elevated Railroad, which is about to be equipped with electricity as a motive power.

ELECTRIC TRACTION STOCKS.

	Bid.	Asked
Union Ry. Co. (Huckleberry)	130	136
Brooklyn Traction pfd.	68	71
" " common	13½	15
Long Island Traction	13¾	14
Rochester St. Ry	40	41
Columbus St. Ry	45	50
Louisville St. Ry. pfd	87	88
" " " common	37	39
Cleveland Electric Ry.	45	47
Cleveland City Ry.	56	58
North Shore Traction	22	—
New Orleans Traction	59½	—
Worcester Traction pfd	82	86
" " common	14½	16
Metropolitan Traction Philadelphia	106½	107
Philadelphia Traction	102	102½
People's Traction	55	55½

BONDS.

	Bid	Asked
*Union Ry. 1st. mtge 6s	105	108
*Westchester Electric 1st. m. 5s	98	101
Rochester St. Ry. 1st. 5s	95	97
*Columbus St. Ry. 1st 5s	89	92
Columbus Crosstown 1st. 5s	95	97

*With accrued interest.

Special Correspondence.

New England Notes.

Branch Office of The Electrical World,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, December 8, 1894.

THE WEST END STREET RAILWAY COMPANY, Boston, has given an order for 110 motors, divided equally between the General Electric Company and the Westinghouse Electric & Mfg. Company.

THE PETTINGELL-ANDREWS COMPANY, Boston, is rearranging its display windows so as to neatly and tastefully exhibit its various electrical specialties. Its recently introduced "retail department" has already become quite a feature, and the trade is constantly manifesting its appreciation of it by liberal patronage.

THE NEW ENGLAND SCREW COMPANY, Boston, has every reason to congratulate itself upon its new and spacious quarters at 240 Dover street, that city. This company, by the way, enjoys with the electrical trade an excellent reputation and business recognition in its particular specialty, the manufacture of brass and iron machine screws, and Secretary and Treasurer T. P. Swift is just the man to hold trade and increase it.

THE WHITNEY ELECTRICAL INSTRUMENT COMPANY, Penacook, N. H., has appointed as its agent for the State of West Virginia and the western part of Pennsylvania, Mr. H. S. Sands, of Wheeling, W. Va., who will hereafter carry a line of its well known instruments sufficient to meet the wants of the trade in that territory. Mr. Sands has already made for himself quite a reputation as a contractor and engineer, and will undoubtedly make a success of this agency.

CHANDLER & FARQUHAR, Boston, dealers in machinists' supplies, etc., have removed to new and more commodious quarters at 36 Federal street, that city. The new quarters extend through from Federal to Congress street. This

firm needs no introduction to the electrical trade of New England, as it is favorably and generally known to everybody. Among its important agencies are the Garvin Machine Company, of New York, and the Lodge & Davis Machine Tool Company, of Cincinnati, Ohio.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
936 Monadnock Building, Chicago,
December 8, 1894.

MR. W. H. McKINLOCK has gone to New York for a short visit.

THE ELKHART TRANSFORMER continues to grow in favor, if orders are any indication. President Boss was a Chicago visitor during the week.

ROTH & ECK, of 32 Market street, are now making a specialty of dynamos of very small capacity, at remarkably low figures. It will pay anyone to communicate with them.

MR. R. HUMFFREYS-ROBERTS, secretary and manager of the Fontaine Crossing and Electrical Company, of Detroit, Mich., was one of the most prominent of Chicago visitors during the week.

THE CHICAGO INSULATED WIRE COMPANY reports a very large order of wire sold to the North and West Side Street Railway Company amounting to 40,000. Business is very good with this company which has recently had to enlarge its factory at Sycamore to supply its enormous trade.

THE METROPOLITAN ELECTRIC COMPANY has nothing to complain of in the way of business. It is very busy in all departments, especially so with wires and cables. N. I. R. are three letters that seem destined to occupy the widest possble attention among the popular brands of wire in the west.

News of the Week.

NEW INCORPORATIONS.

THE UNIVERSAL ELECTRIC CONSTRUCTING COMPANY, Detroit, Mich., capital stock $5,500, has been incorporated by J. H. Talbot and others.

THE CITIZENS' MUTUAL TELEPHONE COMPANY, Lockport, N. Y., capital stock $15,000, has been incorporated by Jos. A. Ward, Wm. V. Trevor and others

THE WHITE HALL ELECTRIC COMPANY, White Hall, Ill., capital stock $10,000, has been incorporated by Gilbert S. Vasseller, Orlando F. Griswold and Henry W. Hand.

THE GLOUCESTER AND ROCKPORT STREET RAILWAY COMPANY, Gloucester, Mass., capital stock $40,000, has been formed to locate, operate, construct and maintain a street railway from Gloucester to Rockport.

THE RAVENNA ELECTRIC STREET RAILWAY & POWER COMPANY, Ravenna, O., capital stock $50,000, has been incorporated by Geo H. Worthington, Wm. J. Akers, Geo. W. Gardner, John H. Evans and R. B. Carnahan.

THE MADISON SQUARE LIGHT COMPANY, New York, N. Y., capital stock $1,000, has been formed to manufacture, use and sell electricity. The promoters are G. W. Moslin, A. J. Freeland, New York City, and R. D. Lankford, Brooklyn, N. Y.

THE WINAMAC ELECTRIC LIGHT & POWER COMPANY, Winamac, Ind., capital stock $10,000, has been formed to manufacture and supply electric light and power. John H. Weaver, Moses A. Dilts and Isaac V. Smith are the organizers.

THE HOME TELEPHONE COMPANY, Plain City, O., has been incorporated by W. C. Bollinger, W. H. Schierer, Charles Dun, J. C. Thompson, J. A. Kile, A. Lee Seeley, G. W. Gardner, Albert Hauer and F. N. Mattoon. The capital stock is $5,000.

THE UPPER CICERO WATER & LIGHT COMPANY, Austin, Ill., capital stock $50,000, has been formed to furnish electric light, heat and power, to lay water and gas pipes, etc. Lawrence Crook, Joseph Foschinbaur, Revere Lincoln and Daniel Schustick are the incorporators.

THE GREENSBURG, JEANNETTE & PITTSBURG STREET RAILWAY COMPANY, Carlisle, Pa., capital stock $150,000, has been formed to construct, maintain and operate an electric street railway. W. F. Sadler, A. A. Thomson and W. F. Sadler, Jr., of Carlisle, Pa., are the promoters.

THE CHATHAM ELECTRIC LIGHT & POWER COMPANY, Savannah, Ga. capital stock $25,000, has been incorporated to operate electric light and power plants. The promoters are George Parsons, James H. Johnston, John N. Harriman, Ed. J. Thompson and others, to operate electric light and power plants.

THE CORNING & PAINTED POST STREET RAILWAY, Corning, N. Y., capital stock $100,000, has been formed to build and operate an electric street railway five miles long between the towns of Corning and Painted Post. The interested parties are E. W. Sheed, W. H. Tylee, Worcester, Mass., and H. A. Clark, Corning N. Y.

THE ROGERS PARK LIGHTING COMPANY, Chicago, Ill., capital stock $30,000, has been formed to generate, buy and sell electricity, and to manufacture gas; also to construct and lay all necessary wires, pipes, poles, conduits and appliances for the distribution thereof. Henry Heistand, Geo. N. Stone and Lloyd G. Kirkland are the promoters.

THE DELAND ELECTRIC RAILROAD & POWER COMPANY, De Land, Fla., capital stock $300,000, has been formed to construct, maintain and operate a railway with electricity as a motive power, and also to supply electric current for lighting, etc. John B. Stetson, Theodore Search, Philadelphia, Pa., and John F. Forbes, DeLand, Fla., are the promoters.

THE MAHONING VALLEY ELECTRIC RAILWAY COMPANY, Niles, Ohio, capital stock $150,000, has been formed to construct and operate street railways by electric or other motive power, excepting horse or steam power, in Niles, Girard and Youngstown, and between these towns. C. F. Clapp, R. G. Sykes, Arthur A. Anderson, G. E. Herrick, Andrew Squire and John E. McVey are interested.

THE RAVENNA ELECTRIC STREET RAILWAY & POWER COMPANY, Ravenna, O., capital stock $50,000, has been formed to build, operate and maintain electric railways within the limits of Portage County, Ohio, and elsewhere; also to furnish electric power, light and heat, etc. George H. Worthington, Wm. J. Akers, George W. Gardner, J. H. Evans and R. B. Carnahan are the promoters.

THE AMERICAN GAS ENGINE ELECTRIC COMPANY, Chicago, Ill., capital stock $250,000, has been formed for operating patents for producing power by gas engines, electric motors, etc.; generating electricity for light, heat and power, and to manufacture electric cooking, heating and refrigerating apparatus. Erik Akerberg, J. Ensign Fuller and Albert F. Dexter are the interested parties.

THE MERCED RIVER POWER AND WATER COMPANY, San Francisco Cal., capital stock $1,000,000, has been formed to build and operate railways, bridges, telegraph and telephone lines, water-works, flumes, dams, and to distribute water, electricity, etc. G. A. Wulkop, Merced; Sumner W. Bugbee, Oakland; H. L. Norton, F. C. Roberts, and W. S. Morgan, San Francisco, Cal., are the interested parties.

ELECTRIC LIGHT AND POWER.

MORRIS, N. Y., is in need of an electric railway and electric lights.

SCHENEVUS, N. Y.—The question of electric lighting is being agitated.

HARTFORD, CONN.—The matter of placing electric wires underground is being agitated here.

WENONA, ILL.—A special election will be held to vote on the question o lighting the city by electricity.

GADSDEN, ALA.—The capacity of the Queen City Electric Light Company's plant will be largely increased.

RUSHVILLE, ILL.—Rushville wants more electric lights. An 85-hp engine will be added to the present plant.

KIRKLAND, ILL.—The citizens are talking of establishing an electric lighting plant. Address H. B. Rowen.

PANAMA, N. Y.—The village trustees have voted to procure street arcs for the borough. About 36 lamps will be required.

ERIE, PA.—The city clerk was instructed to advertise for bids for street lighting for the year commencing in April next.

ONTONAGON, MICH.—An electric plant to be run by water power at the falls of the Ontonagon river, is among the probabilities.

BERWYN, PA.—Citizens are talking about having the streets lighted by electricity, the current to be brought from the plant at Wayne.

DANSVILLE, N. Y.—The committee on county buildings have been directed to ascertain the expense of fitting up the county buildings for electric lighting.

SHAWANO, WIS.—The council has rejected both bids submitted for the purpose of furnishing the city with electric light, for the reason that they were considered too high.

LANCASTER, PA.—The Lancaster Gas Light and Fuel Company has applied for an alteration of its charter and the change of name to the Consolidated Gas & Electric Company. H. B. Baumgardner is president.

CARTHAGE, MO.—Press states that Mr. A. O. Ihlseng is preparing to operate continuously his mines in the southwestern suburbs, and also to construct an electrical light plant for lighting the works above ground.

WHEELING, W. VA.—A charter has been granted the Suburban Light & Water Company, of Wheeling, with a capital of $500,000, to build an electric light and power plant and water works to supply half a dozen suburban villages.

PHILADELPHIA, PA.—At a convention of delegates of the Peoples' Party it was resolved that the city build and operate an electric light plant, sufficiently large to adequately supply, at cost, the public and private needs of the city.

MILWAUKEE, WIS.—At the meeting of the Council resolutions providing for the operation of the Broadway and the Oneida street bridge by electricity, at a cost of $875 for the Broadway bridge and $600 for the Oneida bridge, were reported.

RALEIGH, N. C.—The stockholders of the Raleigh Electric Company have decided to authorize an issue of $25,000 of first mortgage bonds for the purchase and installation of its electric light plant, and to improve and enlarge its railway equipment.

PLAINVILLE, CONN.—The Plainville Electric Light & Power Company has been organized. The stockholders are C. S. Landers, trustee for Central Railway & Electric Company; W. H. Brayton, M. B. Hitchcock, E. F. Tomlinson and others. The capital is $10,000.

PHILADELPHIA, PA.—The Common Council has granted the Edison Electric Light Company the privilege of laying its conduits throughout the business section of the city between South and Callowhill streets, and the Delaware and Schuylkill Rivers without compensation.

WINNIPEG, MAN.—The Council of the city of Winnipeg, Manitoba, is prepared to receive proposals for the establishment and operation of works for the supply of gas or gas and electric light for the lighting of buildings. Proposals will be received until January 22, 1895.

NIAGARA FALLS, N. Y.—The Niagara Falls Hydraulic Power & Manufacturing Company submitted to the Common Council its plan for constructing one of its lines for transmitting electricity for power, heating and lighting purposes. The matter was referred to the Street Committee.

BLOOMFIELD, N. J.—The Bloomfield Township Committee on Public Lighting has been authorized to advertise for bids for supplying the town with 100 2000-cp electric lights. A local electric light and power company is being organized in the town for the purpose of bidding for the contract.

BESSEMER, ALA.—The Howard Harrison Iron Company has closed a contract for the electrical equipment of its revolving cranes in their foundry. Each of five cranes is to be equipped with two 10-hp and one 30-hp motor. Power is to be furnished from a 150-kw 500-volt generator.

THE ELECTRIC RAILWAY.

NEW BRITAIN, CONN.—The Central Railway & Electric Company has asked permission to extend its lines.

SOMERSET, MASS.—There is much probability of a spirited contest for an electric railroad franchise in this town.

WORCESTER, MASS.—The Natick Electric Street Railway Company has about completed its line to South Framingham.

NORTHAMPTON, MASS.—The Northampton Electric Railway Company is to be extended to East Hampton at a cost of $100,000.

SAVANNA, ILL.—J. B. Canterbury, of La Crosse, Wis., is interested in organizing a stock company to construct a street car line in Savanna.

DETROIT, MICH.—The City Council has granted a franchise to representatives of the Park-Everett syndicate for another electric street railway line.

JAMAICA, L. I.—After innumerable delays and postponements the contract giving a franchise to the Long Island Electric Company was executed December 3.

PEEKSKILL, N. Y.—The Peekskill, State Camp and Mohegan Railway Company has received a franchise to build an electric street railway in Peekskill.

WELLSTON, O.—The Wellston Belt and Street Railway Company has filed an amendment changing its name to the Wellston & Jackson Belt Railroad Company.

HOBOKEN, N. J.—The stockholders of the Bergen Turnpike Company have given the directors power to issue bonds to build a trolley road from Hackensack to Hoboken.

CRAWFORDSVILLE, IND.—C. E. Loss & Company have been awarded the contract to construct the Anderson and Muncie Electric Railway. The price to be paid, it is stated, is $525,000.

ORANGE, N. J.—The Suburban Traction Company has passed into the hands of a receiver. The company's resources are stated to be $500,000 and its liabilities $1,500,000 in bonds, and $141,000 in debts.

GRAND RAPIDS, MICH.—J. H. Roberts, it is reported, will put an electric railway around Mackinac Island at a cost of $100,000, and will also establish an electric light plant which will cost $50,000.

HARRISBURG, PA.—The Cumberland Valley Railroad will extend its lines to Carlisle. The company proposes putting in an electric trolley system on its own line between Harrisburg and Dillsburg in the spring.

DOYLESTOWN, PA.—The first work on the Doylestown trolley line has been commenced under supervision of ex-Register Frank N. Booz. A force of workmen began the erection of poles along Maple avenue.

GREENVILLE, N. J.—The Common Council will consider the petition for a franchise presented by the Jersey City, Hoboken & Rutherford Electric Railway Company to operate a trolley system along the Paterson plank road.

VANCOUVER, B. C.—The Street Railway and Electric Light Company has been sold to an English syndicate. Notice of dismissal has been given all employees and the new company intends to completely reorganize the staff.

SOUTHBORO, MASS.—The new company known as the Marlboro and Westboro Street Railway Company has petitioned the Board of Aldermen of Marlboro for a right to lay a track to Northboro, going over the westerly part of Southboro.

BATAVIA, N. Y.—A franchise for an electric street railway in Batavia and to Horse Shoe Lake has been granted to the Batavia Street Railway Company. The New York Standard Construction Company, 97 Nassau street, has the contract for construction.

ALBANY, N. Y.—It is rumored that should the proposed new bridges across the Hudson at Bath and between Green Island and Troy be erected, an electric railroad belt line will be constructed between Troy and Albany. When the new bridge from Troy to Green Island is built the tracks of the Troy City road will be laid across it.

KINGSTON, N. Y.—The Colonial City Electric Railway Company has asked for consent of the Common Council of the city of Kingston to build, maintain and operate a trolley system on its railway in certain streets of the town. David Kennedy is Mayor.

DUBOIS, PA.—Adjutant General W. W. Greenland is interested in having the Beach Creek road extended from Dubois to Franklin, where it would connect with the Lake Shore and form a trunk line to include Clarion. The General says the extension will undoubtedly be made.

SOUTH WILLIAMSPORT, PA.—The South Williamsport Railway Company has secured a charter permitting it to extend its line from the present western terminus at Maynard street on through to DuBois town. The company have decided to begin the work of construction next spring.

NEWARK, N. J.—The Consolidated Traction Company is building a large power house to take the place of its old 3,000-hp Boyd street plant. The electrical equipment of the old plant consists of 14 units, Edison, Westinghouse and T.-H. generators. The new station will have only large units 500 to 1,000-hp each.

BRIDGEPORT, CONN.—The Bridgeport Traction Company is installing an additional 300-kw direct coupled generator in its power station. It was necessary to secure a truck from New York to haul the armature from the freight yard to the power house, as no local truck was strong enough to support the twenty-ton weight.

TRAVERSE CITY, MICH.—Articles of association were filed for a standard gauge electric railway from Traverse City to Old Mission, 20 miles, with a capital stock of $160,000. It is intended to be a freight and passenger line. The incorporators are ex-Judge Jonathan G. Ramsdell, L. K. Gibbs, Harry L. Gibbs and others.

ALBION, N. Y.—The International & Oak Harbor Railway Company has applied for a charter to construct a railway to be operated by steam, electricity or other power from Albion, Orleans County, to Lake Ontario, a distance of ten miles. The capital is $175,000, and the directors are George A. Wingate, Jacob Cole, of Albion, and others.

DEPERE, WIS.—James H. Elmore and Frank Van Derzee have been granted a franchise by the City Council for an electric street railway connecting with the Green Bay system, upon the condition that the railroad shall cross the river on a bridge of the railway company's own construction, and run to the Chicago & Northwestern depot.

PHILADELPHIA, PA.—At a special meeting of the stockholders of the 22nd street and Allegheny Avenue Passenger Railway Company a resolution recommending several extensions, submitted by the Board of Directors, was approved, and the officers authorized to take steps to obtain authority for the construction of the proposed extension and to proceed with their construction.

SWEDESBORO, PA.—What was thought to be a scheme to be force the Camden, Gloucester & Woodbury Company to build a road from Woodbury to this place has developed into the formation of a permanent company which will operate a road between these two points. The right of way has been secured over the Salem and Woodbury turnpike from this place to the terminus of the road in Woodbury.

SOUTH FRAMINGHAM, MASS.—The South Middlesex Electric Street Railway Company will extend its line to Ashland and Hopkinton. The directors for the ensuing year are W. B. Ferguson, of Malden; Thomas T. Robinson, of Dedham, and others. The president is W. R. Ferguson; clerk and treasurer, Joseph J. Valentine. The treasurer's office and headquarters will be at South Framingham.

WOODBURY, N. J.—It is now proposed to run an electric road by the underground conduit system between this city and Swedesboro. The company claim to have secured an option on the stock of the latter company and the road will be completed by summer. The route embraces Delaware street to Jackson, to High, to Glower, to Penn, to Morris, to Salem avenue, then over the turnpike to Clarksboro and Swedesboro. Reported at Swedesboro, Pa., Dec. 3rd.

PITTSBURG, PA.—Charters have been issued for three new street railways in Pittsburg, two being controlled by the same parties, the Baum Street and Highland Park Street Railway Companies. The other is the Liberty Traction Street Railway Company. The Baum Street Railway Company is capitalized at $10,000, and will build a line about a mile long; and the Highland Park Street Railway is capitalized at $25,000 and will build a line three miles long: Senator William Flinn, of Pittsburg, is president of these two companies, and Joshua Rhoades, William C. Lynne, James A. Fortune, Wm. McAdams, Pittsburg, are directors. The Liberty Traction Company is capitalized at $70,000. The company will build a line of ten miles from the intersection of Eleventh street and Spring alley. The president is John F. Scott, Pittsburg, and the directors are Geo. S. Davison, P. Rhoades Baker, W. F. Bickell, of Pittsburg, and others.

Trade and Industrial Notes.

MESSRS. H. B. COHO & CO., 203 Broadway, New York, have received the order for electrical machinery for the new Coffee Exchange, New York City, through the Metropolitan Electric Equipment Company.

LINTON & SOUTHWICK, Worcester, Mass., in a recent catalogue illustrate and describe a number of their electric light, power and switchboard fittings.

THE PHILADELPHIA ELECTRICAL & MANUFACTURING COMPANY has moved its works from 1710 Barker street to Twentieth and Jones streets, Philadelphia.

QUEEN & COMPANY, Philadelphia, Pa., we learn, consider the prospects excellent for a speedy adjustment of their affairs. Meanwhie their large stock has suffered little diminution and is being kept up in all departments, orders being filled as usual.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, 1108 Charles street, St. Louis, Mo., has issued a new discount sheet applying to its new 15-ampere 500-volt switch. This switch has been designed to meet underwriters' requirements and has met with much success.

THE INTERIOR CONDUIT & INSULATION COMPANY, 44 Broad street, New York, has received notice from the New York Board of Fire Underwriters that it has amended Rule 22 so as to prevent twin conductors to be used in a complete, fully-insulated, continuous iron conduit.

MARK A. REPLOGLE, Cedar Falls, Iowa, is applying his turbine regulator to a pair of Leffel's horizontal Samson wheels at Burlington, Vt., used to furnish power to street railway generators. Mr. Replogle has met with much success with his system for controlling the speed of turbines under variable load.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, 50 Broadway, New York, in a handsome 8-page pamphlet describe and illustrate a number of its incandescent arc and series arc lamps. The principle of the incandescent arc is clearly shown in two cuts and there are several cuts showing the handsome manner in which the lamps are finished.

CHICAGO INSULATED WIRE COMPANY, Northern Office Building, Chicago, requests us to give publicity to the fact that the present Chicago Insulated Wire Company is a separate and distinct corporation and has no connection whatever with the Great Western Manufacturing Company, as reported in a dispatch in the daily press, the old charter having been surrendered and a new company formed.

J. E. DUVAL, contractor and construction engineer, having headquarters at Charlotte, N. C., has been unusually successful in this fall's business. During the last sixty days he has installed three new Loomis slow speed generators, two 250-light and one 350-light, besides three of a smaller size. Trade is booming among the cotton mills in the South, and Mr. Duval seems to be getting his share of the lighting business.

J. GRANT HIGH & COMPANY, 123 N. Third street, Philadelphia, and 807 Medina Temple, Chicago, have met with much success with their new high tension switch. This style of switch is at the present time in use on the Roxborough and Inclined Plain Railway and the Pottston and Ringing Rocks road, and they are fitting out with these switches several large railway boards under construction in their shop at the present time.

M. T. DAVIDSON, Brooklyn, N. Y., with New York headquarters at 77 Liberty street, has recently filled some big orders for Davidson pumping engines. One for the water-works of the city of Chelsea, Mass., is a splendid piece of work, as is also a pumping engine of similar magnitude and design for the water-works at Fall River, same State. A large order from a prominent phosphate company in Florida consisted of the entire equipment of its steam plant, including boilers, pumps, etc.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has orders for a number of its new type of electric locomotives, both for the anthracite coal district as well as the bituminous district. As this company is specially fitted up in its machine shops for designing and manufacturing this class of machinery, it claims that it can both build and sell a cheaper and better locomotive than companies devoted to the manufacture of this apparatus only as a small side line.

THE EUREKA TEMPERED COPPER COMPANY, North East, Pa., has issued a neat 40-page catalogue of its manufactures of tempered copper for electrical and mechanical purposes. Numerous lists are given of the various types and sizes of commutators for which this company supplies the segments, or the commutator complete if desired. Other articles mentioned are brushes of all the types used on the different commercial machines, woven wire brushes, street car bearings and gears, trolley wheels, brush holders, soldering coppers, Eureka wire, etc.

THE STANDARD PAINT COMPANY, 2 Liberty street, New York, reports that the Metropolitan Electric Company, 186 Fifth avenue, Chicago, has of late sent them some very large orders for P. & B. compound motor cloth and tape, especially the last named article, it having within the last month alone ordered several thousand pounds of P. & B. insulating tape. Although the Metropolitan Electric Company took up the sale of these goods during the recent hard times, and has been handling them but little over a year, it in that time has doubled the P. & B. electrical business in the West.

THE HAWLEY DOWN DRAFT FURNACE COMPANY, 805 Security Building, Chicago, has issued a large, handsomely printed and illustrated catalogue devoted to the Hawley down draft smoke-consuming furnace. In a recent proposition made by the Hawley Company to the Chicago School Board, the following guarantees were offered as to the efficiency of the Hawley furnace: First—To consume 95 per cent. of the smoke, burning any grade of bituminous coal; second—To make steam for one-half the cost of doing it with hard coal; third—To make steam at 15 per cent. less than present cost with soft coal; fourth—To develop sufficient steam power to furnish all heating and power needed.

S. MORGAN SMITH, of York, Pa., manufacturer of "Success" and "McCormick" turbines, reports the following sales. Ten horizontal iron cased wheels rated at 6,000-hp for the Sacramento Power & Light Company, of San Francisco, Cal., for its plant at Folsom. This is one of the largest power plants in the country; the power will be transmitted 21 miles to Sacramento. The plant will probably be in operation early in the spring. Also horizontal wheels aggregating about 2,000-hp for the Minneapolis General Electric Company, of Minneapolis, Minn. Six wheels aggregating about 900-hp were recently furnished the Home Electric Light & Power Company, of Elkhart, Ind.; three wheels and power connections for the electrical plant of the International Pulp Company, Gouverneur, N. Y.; three horizontal wheels of 600-hp and power connections for the new plant of the Mauch Chunk, Heat, Light & Power Company, Mauch Chunk, Pa.; one wheel of 100-hp for an electrical plant at Juneau, Alaska, and one of 275-hp to Salvador, San Salvador.

THE J. H. McEWEN MANUFACTURING COMPANY, Ridgway, Pa. reports the following as among its recent engine sales: Two 150-hp simple, direct connected to General Electric generators, Continental Hotel, Philadelphia; one 350-hp simple direct-connected to Walker generator, to Akron Street Railway Company, Akron, Ohio; two 60-hp tandem compounds, direct-connected to C. & C generators, to Dundee Rapid Transit Company, Elgin, Ill.; one 50-hp simple, to Parmele-Eccleston Lumber Company, Jacksonville, N. C.; two 130-hp tandem compounds to R. Dunsmir & Company, San Francisco, Cal.; two 300 hp to Granite Steel Company, East St. Louis, Mo.; one 150-hp simple engine to Huntingdon Electric Light Company, Huntingdon, Pa.; one 175-hp to J. H. Somers Fuel Company, Belle Vernon, Pa.; one 280-hp tandem compound to Scranton Electric Construction Company, Scranton, Pa.; one 125-hp simple to New York & Pennsylavinia Company, Johnsonburg, Pa.; one 85-hp simple to Independent Electric Company, Atchison, Kansas; one 100-hp to New York & Scranton Coal Company, Shippler, Pa.; one 175-hp simple to Walter & Ferris Coal Company, Salem, Ohio, and one 125-hp simple to Scranton Electric Construction Company, Scranton, Pa.

Business Notices

WOVEN WIRE BRUSHES.—The Belknap Motor Company, of Portland, Me., are the patentees and manufacturers of the best woven wire commutator brush on the market.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

A RAILROAD DOCTOR'S PRESCRIPTION.—General Western Agent C. K. Wilber, of the Lake Shore & Michigan Southern Railroad, with headquarters at Chicago, is, without trying, one of the really funny men of the railroad world. The other day, for example, he accomplished this advertisement, which old hands at the business truly say is one of the brightest little things ever put on paper:

R

The Lake Shoe Limited taken regularly on your Eastern trips will prevent that tired feeling so often experienced by travelers.
Leaves Chicago, V.XXX P. M.
Arrives New York, VI.XXX P. M.

C. K. WILBER,
W. P. A.

Can be taken without shaking.

General Passenger Agent Daniels says that Dr. Wilber's prescription is equally efficacious on trains of the New York Central, he having this assurance from Drs. Cosby and Dumond, who have tried it with perfect success. General Passenger Agent Fee, of the Northern Pacific, has offered to all his local agents and subordinates a handsome prize in money for the best advertisement of the line, and it is obviously well for them that Mr. Wilber "isn't in it."—*Brooklyn Standard-Union.*

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DECEMBER 5, 1894.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

530,082. TELEGRAPH KEY; Louis D. Bliss, Washington, D. C., assignor to Charles W. Needham, of same place. Application filed March 7, 1894. A noiseless transmitting key, comprising a non-resonant support, and a contact mounted on the support.

530,088. BRUSH FOR DYNAMO-ELECTRIC MACHINES; Pierre Joseph Charles Carron, Pont-de-Claix-Isere, France. Application filed February 10, 1894. A brush for an electrical machine comprising a sheet of wire gauze, coated and impregnated with a paint composed of plumbago and an adhesive substance, the said coated sheet having its main portion arranged in zig-zig folds and its outer portion wrapped about the folded portion and its free end secured.

530,093. ELECTRIC RAILWAY SIGNALING; W. Daves, Jersey City, N. J. Application filed May 24, 1894. The combination of a signal circuit, a normally de-energized track circuit controlling the signal circuit and including the rails of a section of the track, a second normally close track circuit controlling the first mentioned track circuit and including the rails of a separate section of the track.

530,114. METHOD AND MEANS FOR OPERATING AND CONTROLLING ELECTROMOTORS; Carl Moderegger, Vienna, Austria-Hungary, assignor to Siemens & Halske, Berlin, Germany. Application filed December 16, 1893. The method of operating and controlling an electromotor which consists in passing a current through the motor in either direction; and automatically reversing the current and varying the resistance of the circuit simultaneously after a determined period of operation.

530,115. TELEPHONE TRANSMITTER; Miles A. Morehouse, Watertown, N. Y. Application filed March 28, 1894. In a telephone transmitter, the combination with the transmitter box and the vibrating diaphragm, of an electrode bar rigidly connected with one side of the diaphragm, paralleled supporting wires arranged horizontally within the top of the transmitter box, and pendant electrodes adjustably connected at their upper ends to said wires and arranged to rest on said electrode bar at an angle.

530,122. SIGNAL APPARATUS; Charles E. Ongley, New York, N. Y., assignor to George J. Schoeffel, of same place. Application filed February 17, 1894. The combination of a signal device, a compass, a switch operated thereby, and means thrown into operation by said switch for operating said signal devices to indicate the points of the compass.

530,141. SERVICE END, CUT-OUT, AND SWITCH-BOX FOR ELECTRIC-LIGHTING CIRCUITS; John VanVleck, New York, N. Y. Application filed May 28, 1894. The combination of house mains and service cable having conductors, provided with flexible end portions at their extremities, threaded bolts, enclosing said end portions and bolts, and a switch mechanism secured to said box and connected with said house mains and said bolts.

530,145. ELECTROMETER; Edward Weston, Newark, N. J.—Application filed April 26, 1893. In an electrometer containing two fixed electrodes and a movable body susceptible of electrification and disposed in inductive proximity to said electrodes, an index for showing the extent of movement of said movable body supported by said body and insulated therefrom.

530,176. ALTERNATING CURRENT MOTOR AND METHOD OF OPERATING SAME; L. Gutmann, Pittsburg, Pa. Application filed October 30, 1889. This consists of establishing a field of rapidly varying intensity by a single-phase alternating or pulsating current, and producing in a motor element whose winding is exposed to the field of force polyphase currents in successive closed circuits of the winding.

530,177. ALTERNATING ELECTRIC MOTOR; Ludwig Gutman, Pittsburg, Pa. Application filed December 23, 1891. The method of transforming electrical into mechanical energy, which consists in subjecting the stationary and rotary elements of a motor to the influence of a uniphase alternating current, establishing in a supplemental winding bi-phase or polyphase currents, and subjecting said supplemental winding to the influence of a magnetic field.

530,178. ELECTRIC CONVERSION SYSTEM; Ludwig Gutman, Pittsburg, Pa. Application filed December 23, 1891. The combination with a single phase alternating current generator of a self-starting synchronous motor-generator in circuit therewith, a commutator for commutating the currents from said motor-generator and translating devices in local consumption circuits fed by said commutated current.

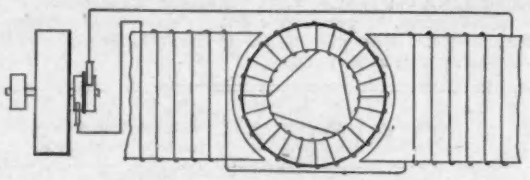
530,184. CIRCUIT-CLOSER; Herbert Vivian Keeson, London, England. Application filed September 17, 1894. The combination of a block or body, an electric circuit through conductors in it, a break in the circuit and two pushes carried by the block or body and acting at right angles or approximately at right angles to each other and closing the said circuit when both are operated simultaneously.

530,191. APPARATUS FOR EXTINGUISHING FIRES; Charles E. Manning, New York, N. Y., assignor to Addison Allen, of same place. Application filed September 9, 1893. An apparatus for extinguishing fires in buildings, comprising a source of water supply, and a source of electricity, an electric motor, a pump driven thereby, electric wires connected to said source of electricity and to said motor, electric switches adapted to close the circuit through said wires and operate said motor, water pipes leading from said water supply to said pump, and from said pump through the building a plurality of branch pipes, and indepeudent valves for each leading from said water pipes, and a hose connected to each of said branch pipes.

530,192. ELECTRIC RAILWAY SYSTEM; David Mason, New York, N. Y. Application filed February 16, 1894. The combination, with a working conductor, and a main conductor or lead, of means whereby the working conductor may be heated, and electrical connections between the main and working conductors.

530,208. TELEPHONE SWITCH; Alfred Stromberg and Androv Carlson, of Chicago, Ill. Application filed October 9, 1894. In a telephone switch, the combination with the support comprising a hook provided with two limbs between and from which the telephone is adapted to be suspended, of a pivoted lever, the end thereof occupying a position between said limbs, whereby said lever will be rotated when the telephone is hung up, and contact terminals controlled by the rotation of said lever for opening and closing the circuits through the telephone apparatus.

530,235. MAGNETO-ELECTRIC MACHINE; Joseph N. McLeod, Brooklyn, N. Y. Application filed April 2, 1894. In a magneto-electric machine, the combination with the rotary armature, and the toothed rack bar and ratchet wheel for operating said armature, of a circuit breaker consisting of the



No. 530,176.—Alternating Current Motor.

stationary and movable parts normally in contact and connected in the local circuit and respectively connected with the line wires, the lever connected with the movable part of said circuit breaker, the collar connected with the lever and the tappet arm of the ratchet wheel adapted to have contact with the collar to break the circuit when the rack bar nearly reaches the end of its movement for operating the armature.

530,236. SIGNALING APPARATUS; Bernice J. Noyes, Boston, Mass., assignor to George W. Gregory, of same place. Application filed February 18, 1890. In a signaling apparatus, a main signaling circuit connecting street boxes, a central station, and a wagon house, a receiving instrument at the receiving staton for receiving all signals, combined with a receiving relay at the wagon house, a retarded armature therefor, a local circuit controlled by the said retarded armature, and two receiving instruments in said local circuit, one at the wagon house and the other at the central station.

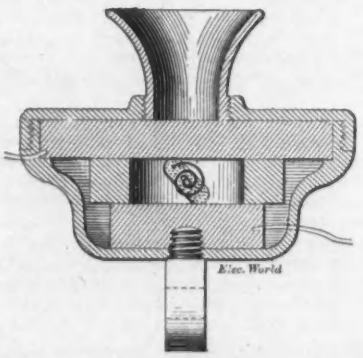
530,253. ELECTRIC BELL; Edward G. Worley, New York, N. Y. Application filed June 13, 1894. In an electric signalling device, the combination on a casing, magnet, an armature and hammer, a back contact spring supported on said casing but insulated therefrom and connected with the coils of the magnet, an insulated stop supported on the casing in front of said spring, and adjusting screw mounted in the casing and having an insulated point to bear on the spring, and connections for the conductors.

530,260. PRIMARY BATTERY; Charles W. De Mott, New York, N. Y. Application filed December 7, 1893. The combination in a primary battery of the jar, the porous cup, the zinc electrode and a copper electrode having the parallel slits and the strips between the slits bent out of the place of the rest of the tube whereby ci culating passages are provided for the solution without lessening the surface area of the copper electrode.

530,276. TROLLEY-CATCHER; William F. Kendt, Buffalo, N. Y., assignor of two-thirds to George M. Mitchell and Rod McLeod, of same place. Application filed May 26, 1894. In a trolley-catcher the combination with a stationary frame or casing having a stop or shoulder and a rotary spring-drum journaled therein, of a detent pawl carried by said drum and engaging with a stop or shoulder of the casing, and a link pivoted to said pawl and adapted to be connected with the trolley rope.

530,286. ELECTRIC TRAMWAY; H. Schwieger, Berlin, Germany. Application filed December 22, 1891. This comprises a conduit, contacts arranged in the conduit, and a series of oppositely arranged yielding guards within the conduit, between which a traveling device from the car is arranged to pass.

530,315. TELEPHONE TRANSMITTER; J. T. Williams, Brooklyn, N. Y. Application filed August 8, 1894. A transmitter consisting of two circuit termi-



No. 530,315.—Telephone Transmitter.

nals, in combination with a conducting body forming an electrical bridge between them and mounted upon a movable axis whereby it may automatically adjust its position with relation to the terminals.

530,324. TELEPHONE EXCHANGE SYSTEM; R. Callender, Brantford, Canada. Application filed August 13, 1892. Means for automatically connecting any two of a series of independent outlying telephone lines, a time mechanism for automatically disconnecting at the central office the subscribers after a predetermined time, which time mechanism is in no way under the control of the subscriber after the expiration of the predetermined time.

530,325. TELEPHONE SWITCH; R. Callender, Brantford, Canada. Application filed September 15, 1894. A sustaining device which fails to hold the receiver when the receiver is being used, in combination with a switch and circuit connections to the call bell and receiver, the switch being provided with means acting conjointly with the support to hold the receiver only when the circuit is closed through the bell.

530,343. ELECTRIC LIGHT FIXTURE; H. Horn, Philadelphia, Pa. Application filed May 24, 1894. This comprises an immovable portion adapted to support a shade, another portion removably connected with the former, the removable part being provided with an open top reflector, the latter being adapted to support and conceal lamp sockets.

530,344. ELECTRIC DENTAL ENGINE; J. A. and B. A. Jeffery, San Francisco, Cal. Application filed April 5, 1894. This comprises a case swiveled upon a bracket, a two part shaft, upon one part of which the motor armature rotates within the case, while the other is journaled in a sleeve extending outwardly in a line with the axis of the motor armature, and a clutch connection between the two parts of the shaft whereby they may be separated when the end of the case is removed.

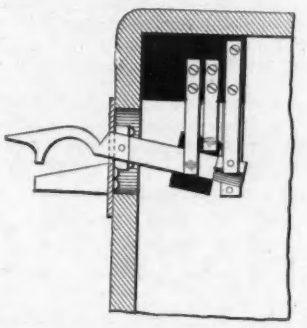
530,351. ELECTRIC METER; G. A. Scheefer, Peoria, Ill. Application filed July 17, 1894. This comprises a rotatable element moved by the current to be measured, a coil connected in parallel with the working circuit, a second coil in inductive relation thereto, the coils being adapted to coact to neutralize the effects of friction.

530,368. BILGE WATER ALARM; C. Upton, Salem, Mass. Application filed February 1, 1894. This comprises a case with terminals, a vertical guide rod within the case, a float guided on the rod, a spiral spring seated on the float and ranging vertically on the case, and a contact plate yieldingly supported on the spring.

530,399. INSULATOR FOR ELECTRIC CONDUCTORS; J. H. Croskey and J. Locke, Pittsburg, Pa. Application filed September 28, 1894. This consists of a metallic conductor covered with a non-metallic mineral and embedded in glass.

530,401. BATTERY CONNECTION; W. S. Doe, Brooklyn, N. Y. Application filed August 27, 1894. This comprises a contact disk surrounded by an elastic ring, and a binding post in electrical connection with the disk.

530,411. BURGLAR ALARM FOR SAFES; J. W. and W. D. Gilstrap, Rolla and Racine, Wisconsin. Application filed April 24, 1894. This comprises a safe, an inner envelope, insulated springs supporting the envelope on the safe, contacts carried by the envelope to touch the safe, an alarm, and a circuit including the safe, the envelope and the alarm.



No. 530,325.—Telephone Switch.

530,416. SELF-LUBRICATING CONTACT BAR FOR ELECTRIC RAILWAYS; F. W. N. E. Hayne, Berlin, Germany. Application filed May 12, 1894. A bar having vertical sides and a beveled contact surface, a receptacle for a lubricant adjacent to the bar, a spongy material against the sides for conveying the lubricant to the contact surface, extending from the receptacle, and a tube connecting the receptacle with a vessel carried on the car and containing the lubricant subjected to a suitable pressure.

530,430. THERMAL CIRCUIT BREAKER; H. Klein, Janesville, Wis. Application filed May 19, 1894. A bowed strip connecting two terminals, the strip being fastened with fusible metal.

530,432. SYSTEM OF ELECTRICAL DISTRIBUTION WITH STORAGE BATTERIES; E. Kuchenmeister, Berlin, Germany. Application filed November 25, 1892. This comprises a generator, circuit and translating devices, a storage battery divided into uniform sections and having one section connected permanently across the circuit and means for connecting the remaining sections in series with the first section, or in parallel with it across the circuit when desired.

530,434. BURGLAR ALARM; J. H. Lowe, Neosho, Mo. Application filed July 20, 1894. This comprises a cage, a case containing noxious fluids under pressure, a valve for same, an atomizing device in the case, circuit closing mechanism in the cage, and means for opening the case valve by the closing of the circuit.

530,465. DYNAMO REGULATOR; J. Van Vleck, New York, N. Y. Application filed October 8, 1894. This comprises two parallel series of contact plates, the plates of one series being opposite the intervals of the other, resistances being interposed between successive plates of each series and a contact piece equal in width to one of the plates and movable over both of the series.

530,472. ELECTRIC SWITCH; J. M. Cronin, Boston, Mass. Application filed September 22, 1894. A double switch having movable members, and an auxiliary controller adapted to be brought in contact with the movable members by operation of the handle.

530,482. ELECTRIC RAILWAY SUPPLY SYSTEM; J. J. Green, Boonton, N. J. Application filed August 21, 1893. This comprises a box, hollow detachable insulating piece therein, a rock shaft extending into the box and carrying a contact lying within the insulating piece, a contact on the inner wall of the insulating piece against which the first named contact works, and means for operating the shaft from the exterior of the box to close the contacts.

530,485. PRIMARY BATTERY; C. J. Hubbell, New York, N. Y. Application filed April 30, 1894. The combination of a primary battery and porous cup, of a reservoir secured thereabove and having a receiving chamber for the fumes and a chamber for the absorbing agent, the chambers being communicating.